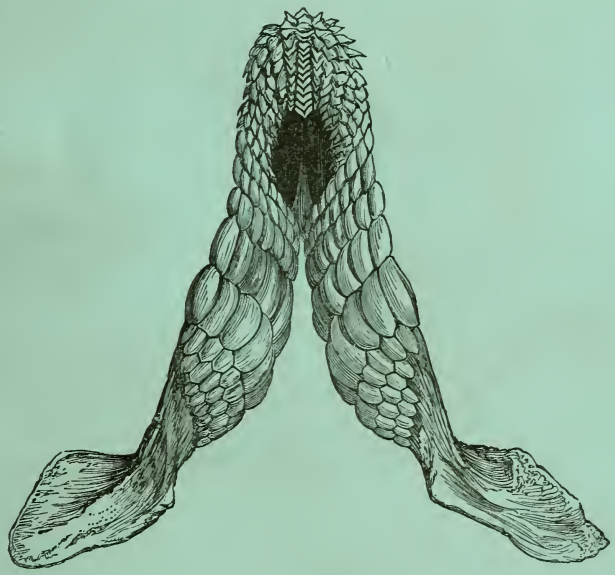
GUIDE

TO THE

COLLECTION OF FOSSIL FISHES

IN THE DEPARTMENT OF

GEOLOGY AND PALÆONTOLOGY,



BRITISH MUSEUM (NATURAL HISTORY),

CROMWELL ROAD, SOUTH KENSINGTON.

LONDON:
[SECOND EDITION.]
1888.

Price Four Pence.

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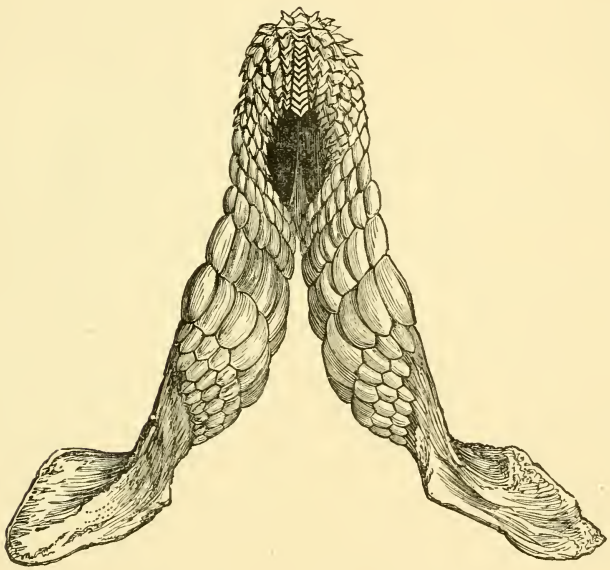

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INTRODUCTION.

The accompanying Guide to the Collection of Fossil Fishes in the British Museum of Natural History has been prepared in the hope that it may prove useful alike to the geologist and the palæontologist.

The Collection is exhibited in Gallery No. 6, the first of the wide North-Eastern Galleries, leading from that in which the Fossil Reptiles are placed. It contains thirty-two Table-cases and about 260 feet linear of Wall-cases.

Here are exhibited the finest collection of Fossil Fishes ever brought together in any Museum. This Class was always well represented in the Department, but it has lately received two splendid additions in the famous collections of the Earl of Enniskillen, D.C.L., F.R.S., from Florence Court, Enniskillen, Ireland; and that of the late Sir Philip de Malpas Grey-Egerton, Bart., F.R.S. (Trustee of the British Museum), of Oulton Park, Tarporley, Cheshire; both obtained by purchase.

These collections, together with those of the late Dr. Mantell, F.R.S., and Mr. Frederick Dixon, F.G.S., previously acquired, with other minor but valuable donations and purchases, now include the majority of the figured types of Agassiz's British Fossil Fishes from his great works, "Recherches sur les Poissons Fossiles" (Neuchatel, 1833-43, 4to. and Atlas, folio); and his "Monographie des Poissons Fossiles du Vieux Grès Rouge, ou Système Dévonien" (Neuchatel, 1844, text 4to. folio plates).

The Gallery has been still further enriched by the purchase of the very numerous and beautiful specimens of Fossil Fishes from the Cretaceous Limestone of Hakel and Sahel-el-Alma, in the Lebanon, obtained through the persevering and energetic labours of the Rev. Prof. E. R. Lewis, M.A., F.G.S., of the Syrian Protestant College, Beirût.

Arrangement.—The Collection, which contains about 450 genera, and 1250 species, commences on the left hand on entering the Gallery, the Wall-cases being used for the larger specimens, whilst the smaller are arranged in the nearest Table-cases.

The names of the orders and families are printed in bold and conspicuous type and repeated in each Case, those of the genera being also repeated upon smaller labels.

It has been found more convenient to arrange the Collection zoologically, rather than stratigraphically.

Every specimen bears, in addition to the genus, species, and author's name, the name of the formation and the locality from which it was obtained; and, if presented, the name of the donor.

Moreover the fishes of the older rocks nearly all belong to families and genera which are now quite extinct. The Plagiostomi—Sharks and Rays—however, offer a remarkable exception, being an order of Fishes whose persistence in time probably exceeds that of any other vertebrate type; whilst in the Dipnoi, one family at least—the *Ceratodi*—has come down to our time from the Devonian epoch, apparently but little modified in the long lapse of geological ages.

References will be found, at the end of the Guide, to the various works in which figures and descriptions are given of specimens preserved in the Collection.

Every "type-specimen" is distinguished by a small disk of green paper affixed to it; and upon the label is a reference to the work in which such "type-specimen" has been figured and described.

The student or visitor who desires intelligently to study the Fossil Fishes in this Gallery will find it indispensable to combine with it a careful examination of the fine collection of living Fishes, prepared and mounted for exhibition in the first North-Western Gallery of the Zoological Department, on the other side of the Great Central Hall.

It is only proper to state here that the Gallery has been arranged by Mr. William Davies, F.G.S., with the assistance of Mr. Arthur Smith Woodward, F.G.S., to whom the writer is also much indebted for valuable assistance in the preparation of this Guide.

HENRY WOODWARD.

Department of Geology,
February 20th, 1888.

LIST OF ILLUSTRATIONS.

FOSSIL FISHES.—GALLERY No. 6.

As the varied layers of sandstone, limestone, and clay, which compose the greater part of the superficial crust of the earth, have been accumulated as sedimentary deposits in lakes, estuaries, and seas, one would naturally expect that, of the Vertebrate division of animals, the remains of Fishes would be most frequently met with in these formations; and such is in fact the case, although, from their fragmentary state, it is not always possible to determine their precise systematic position.

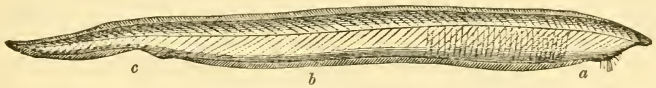

FIG. 1.—The "Lancelet," *Branchiostoma* (*Amphioxus*) *lanceolatum* (recent). *a*, Mouth; *c*, vent; *b*, abdominal pore.

Some fishes have no hard structures capable of fossilization, and such is likewise the case with most of the lower notochordal forms —the "Sea-squirts" and the "Lancelets"—which seem to connect the Vertebrata with the subkingdoms of Invertebrata. The little "Lancelet" (*Branchiostoma*), for example, has only a membrano-cartilaginous skeleton without vertebræ, ribs, or jaws (Fig. 1); while the ordinary Tunicates, or "Sea-squirts," are equally destitute of any but the most perishable tissues. Moreover, even the lowest Fishes—the Lampreys and Hag-fishes—possess no hard structures beyond the minute horny teeth (Figs. 2, 3). If, there-

FIG. 2.

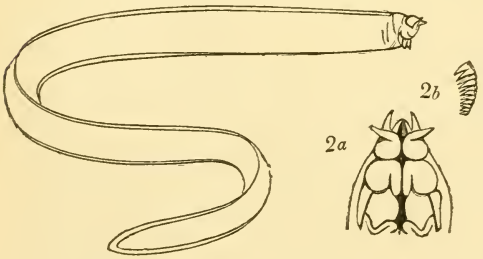

FIG. 3.

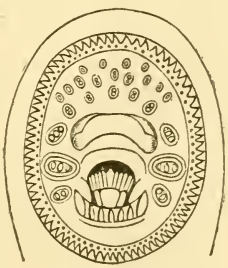

FIG. 2.—The "Hag-fish," *Myxine australis* (recent). *2a*, Lower aspect of head. *2b*, A single detached tooth of *Myxine*.
FIG. 3.—Mouth of Lamprey, *Petromyzon fluviatilis*, showing circular arrangement of teeth.

fore, any of these creatures existed in past geological times, they would leave little or no evidence of their presence among the fossils preserved in the rocks; though it is quite possible—nay even

probable—that the ancestors of some of these soft-bodied types had calcified dermal structures which have become fossilized and now perplex us because there is nothing similar to them in the present world.

Table-case, No. 25.

The earliest known fossils of this character seem to be the little tooth-like bodies, first discovered in the Cambro-Silurian and Devonian formations of Russia and North America, and named by Pander "Conodonts" (Fig. 4). In external form, they are very suggestive of the denticles of the Lampreys and Hag-fishes (Figs. 2, 3), but instead of being chitinous or horny, they consist of phosphate of lime. Dr. G. J. Hinde has also shown that they are associated with little ornamented plates of similar structure and composition, which have no analogues in the living forms just mentioned.

Fig. 4.—"Conodonts" from the Cambrian (after Dr. G. J. Hinde). × 10 times.

Wall-case, No. 1.

The earliest evidence of fish-like vertebrates, other than "Conodonts," consists in a single head-shield of *Scaphaspis ludensis*, from the Lower Ludlow of Leintwardine, Shropshire, discovered by Mr. J. E. Lee, F.G.S. The next is met with in the "Ludlow Bone-bed" of the Upper Silurian Formation. This thin layer consists of fragmentary fish, crustacean, and other remains, among which have been detected small, compressed, slightly-curved, and ribbed fish-spines, named *Onchus*, and some minute shagreen-granules, called *Thelodus*, and a jaw-like fossil, with pluricuspid teeth, named *Plectrodus*; likewise the head-shields of a species of *Scaphaspis*, and other similar fragmentary remains.

Passing over the lower types and the Cyclostomata (Lampreys and Hags) as at present too imperfectly known for systematic treatment, we arrive at the second great order—that of the Plagiostomi, comprising the Sharks and Rays. Next follow the Chimæroidei, only represented at the present day by the two genera of Chimæras, though constituting an important feature in most marine faunas of past geological ages. The Dipnoi, or "Mud-fishes," follow, and are specially noteworthy from the modification of the air-bladder to perform the function of a rudimentary lung. Then there is the order of Ganoidei—remarkable for the frequent possession of highly-enamelled scales and head-shields—represented by innumerable hosts of extinct forms, both marine and freshwater, but almost exclusively confined to a few river and lake-dwelling types at the present time. And lastly, follows the equally extensive order of bony fishes, or Teleostei, which exhibits its maximum development in the existing fauna, and represents the

highest stage of specialization or elaboration to which the piscine class has attained.

In tracing the fishes through the successive ages of the past, it is interesting to note the close correspondence between the history of the race and the history of an individual modern Teleostean, at least in one point—the structure of the tail. All the older members of the class either had the extremity of the body straight and tapering, with the fin equally developed above and below (Fig. 5), or there was a slight upward bend of the vertebral column, with the lower lobe of the tail-fin much larger than the upper (Fig. 6). In later fishes, the upturned end of the body in the unequally-lobed tail has become more and more abbreviated, and the rays of the fin have gradually become so disposed that to all external appearance the tail has assumed perfect symmetry (Fig. 7). Such changes are precisely repeated in the embryonic history of a living Teleostean, in which the tail is first pointed, then upturned, and then externally symmetrical.

FORMS OF TAILS OF FISHES.

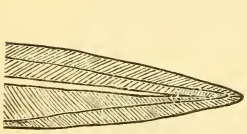

Fig. 5.—Diphycercal.* Primitive form.

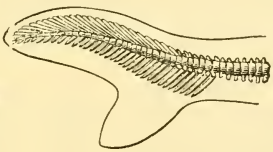

Fig. 6.—Heterocercal.† Ancient form.

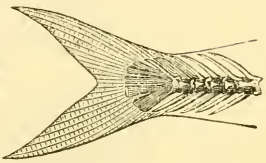

Fig. 7.—Homocercal.‡ Modern form.

Order I.—CYCLOSTOMATA.

No undoubted fossil representatives have hitherto been recognized.

Order II.—PLAGIOSTOMI.

In these fishes the skeleton remains cartilaginous throughout life. The cranium itself is not divided into any distinct tracts by sutures or ossifications, and the two foremost of the "visceral arches" (cartilaginous rods in the walls of the alimentary tube), which are modified as jaws and hyoid cartilages, have a very slight connection with it. The jaws are mainly suspended by the upper element of the hyoid arch (the "suspensorium") and by a ligament in front; or there is sometimes (*e.g.* in *Cestracion* and *Notidanus*) direct contact either behind or in advance of the eye (see Fig. 17). The axial skeleton of the trunk varies from a primitive persistent notochord to a well-calcified vertebral column,

Wall-cases, Nos. 1 to 3.

Table-cases, Nos. 25 to 33.

* *Diphycercal*, double tail-fin. † *Heterocercal*, unequal-lobed tail-fin.
‡ *Homocercal*, equal-lobed tail-fin.

composed of distinct centra. The gills are pouch-like, and there are five (six or seven) distinct clefts on each side, which are exposed, having no "gill-cover," or opercnlum. The body is provided with median and paired fins, the hinder pair being abdominal.

In the majority of the Plagiostomes, the extremity of the vertebral column is slightly turned upwards, and the lower lobe of the caudal fin is much larger than the upper, producing a "heterocercal" tail. In some, however, like *Squatina* and in several of the Rays, the terminal portion of the body is straight, and the fin equally developed above and below, upon the "diphycercal" or "proto-cercal" plan.

The skin is usually covered more or less closely by numerous small detached plates or granules of dentine, with tubercles or spines (Fig. 8) scattered over the whole surface of the integument, commonly known as "placoid scales." When very small and close-set, as in the Dog-fish, this dermal covering is called "shagreen."

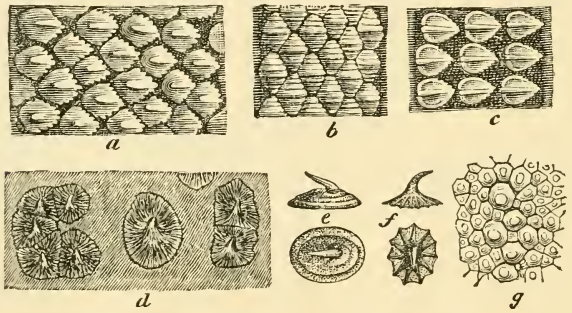

Fig. 8.—Dermal tubercles of Plagiostomous Fishes.
a, shagreen of Dog-fish (*Ginglymostoma*), enlarged; *b*, shagreen of Blue Shark (*Carcharias*), enlarged; *c*, shagreen of Spiny Dog-fish (*Centrophorus*), enlarged; *d*, dermal tubercles of Spiny Shark (*Echinorhinus*), nat. size; *e*, tubercle of Ray; *f*, dermal tubercle of Greenland Shark (*Læmargus borealis*), enlarged; *g*, shagreen of Sting-ray (*Urogymnus*), nat. size.

Those of the Plagiostomes with lateral gill-clefts are commonly known as "Sharks" (Fig. 9), while those with depressed body

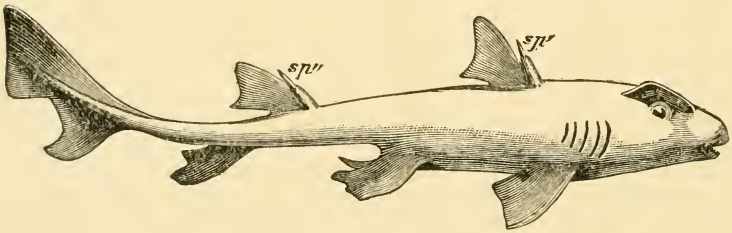

Fig. 9.—Port-Jackson Shark, *Cestracion Philippi*, Lacép., Australia.
sp' anterior dorsal spine; *sp''* posterior dorsal spine.

and ventrally placed gill-clefts fall under the denomination of "Rays" (Fig. 10). There are many intermediate forms, however, which it is impossible to distinguish in a fossil state.

From the perishable nature of their skeletal parts, it is obvious that the palæontological history of these fishes is most difficult to decipher. In the majority of instances, the fossils consist merely of detached spines, shagreen-granules, teeth, or pieces of cartilage; and it is often impossible to correlate these unsatisfactory fragments, so that the different parts of the same species not unfre-

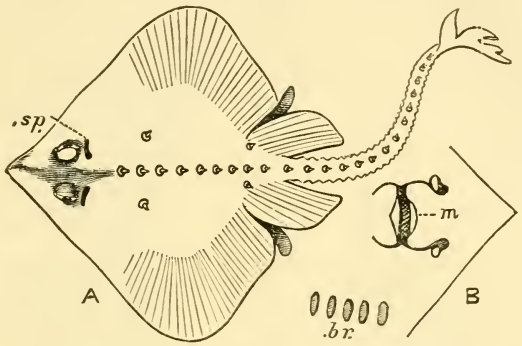

Fig. 10.—The Ray (*Raja Murrayi*, Günther), from Kerguelen's Island.
A, dorsal aspect; B, part of ventral side; *sp*, spiracle; *br*, branchial clefts; *m*, mouth.

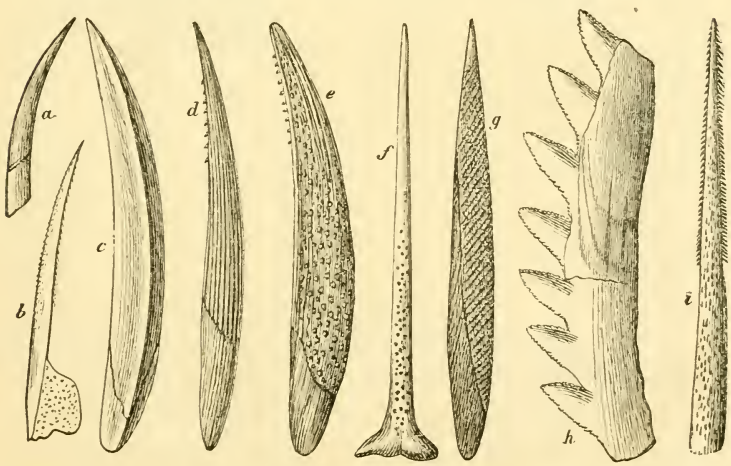

Fig. 11.—Spines of Plagiostomous and Chimæroid Fishes.
a, *Acanthias* (recent); *b*, *Callorhynchus* (recent); *c*, *Machæracanthus* (Devonian); *d*, *Hybodus* (Jurassic); *e*, *Asteracanthus* (Jurassic); *f*, *Squaloraja* (Lias); *g*, *Gyracanthus* (Carboniferous); *h*, *Edestes* (Carboniferous); *i*, *Pleuracanthus* (Carboniferous).

quently receive even distinct generic names. Sometimes, however, complete fishes are met with, and many beautiful examples are shown from the Lias of Lyme Regis, the Lithographic Stone of Bavaria, and the Upper Cretaceous of Mount Lebanon.

Wall-case, No. 3.

Wall-case, No. 1.

Table-case, No. 25.

The first table-case on the left and the adjoining wall-case are filled with numerous spines and other dermal appendages of cartilaginous fishes, perhaps mostly Plagiostomes, which cannot yet be precisely determined; they are conveniently grouped together as *Ichthyodorulites* ("fish-spine-stones") [See Figs. 11—13, pp. 5 & 6].

The earliest evidence of the order is placed here, namely, the dorsal fin-spines from the Ludlow Bone-bed (Upper Silurian) and the Old Red Sandstone, bearing the name of *Onchus*. *Ctenacanthus* is founded upon dorsal spines from the Carboniferous, and a complete fish, with the spines in position in front of the dorsal fins, is exhibited from Eskdale, Dumfries. Possibly some of the teeth named *Cladodus* pertain to the same form. The huge *Phoderacanthus*, three feet in length, from the Carboniferous Limestone of Bristol, is the largest ichthyodorulite known; and there are also triangular paired spines of considerable size from the same formation, which are named *Oracanthus* and provisionally associated with several flat dermal plates having a corresponding ornamentation. Spines of *Edestes* (Figs. 11*h*, 12) occur in the Carboniferous of N. America, Australia, and Russia, and are remarkable for their curvature and the great size of the posterior denticles; the latter are in the form of serrated teeth, and led their first discoverer, Prof. Leidy, to conclude that the fossils were fragments of jaws. *Gyracanthus* (Fig. 13) occurs abundantly in the British Carbon-

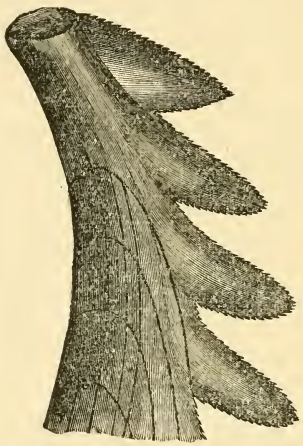

Fig. 12.—Portion of spine of *Edestes vorax*, Coal-measures, Indiana, U. S. North America.

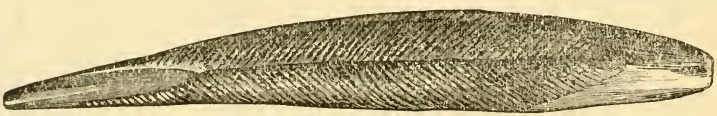

Fig. 13.—Spine of *Gyracanthus formosus*, showing abrasion of the apex, Coal-measures, Scotland.

iferous, and is represented both by the well-known paired spines (with an ornament of angulated ridges, and ordinarily abraded extremity), triangular dermal bones, and shagreen granules: the teeth probably bear another name. *Acondylacanthus* resembles the spine of a Ray: and *Erismacanthus* and *Lispacanthus* are very suggestive of the rostral spine of male Chimæroids.

The Jurassic *Asteracanthus* (Fig. 11*e*) and *Pristacanthus* are evidently dorsal fin-spines, and the former may be correlated in part with the teeth known as *Strophodus*.

The families of *Carchariidæ* and *Lamnidæ* appear to be the characteristic Sharks of modern times. Detached teeth, vertebræ, and portions of calcified cartilage are abundantly met with in Cretaceous and Tertiary formations, but scarcely any are discovered so low in the geological series as the Jurassic. The Cretaceous *Corax* is possibly allied to the living *Carcharias*; and other *Carchariidæ* found fossil in the Tertiaries are *Galeocerdo*, *Zygæna*, ("Hammerheads"), etc. The *Lamnidæ* are represented by *Carcharodon*, *Otodus*, *Lamna* (Fig. 14), *Oxyrhina*, and others; and the remains of the first-named genus are especially worthy of note. The teeth of *Carcharodon* (Fig. 15) seem to occur first in the

Wall-case, No. 3. Table-cases, Nos. 26, 27.

Fig. 14.

Fig. 14.—Tooth of *Lamna elegans*, Agassiz, London Clay.

Fig. 15.

Fig. 15.—Tooth of *Carcharodon megalodon*, Agassiz, Suffolk Crag. (One-third nat. size.)

Upper Cretaceous of Maastricht, Holland, and those of Tertiary times have an almost world-wide distribution. Teeth of the largest species are exhibited from New Zealand, Australia, South Carolina, the West Indies, France, Spain, Italy, Malta, and Arabia, and from the Antwerp and Suffolk Crags.

It is also interesting to notice that in some places, both in the Atlantic and Pacific (especially at extreme depths in the red-clay areas), the "Challenger" dredged up many teeth of Sharks and ear-bones of Whales, all in a semi-fossil state, and usually impreg-

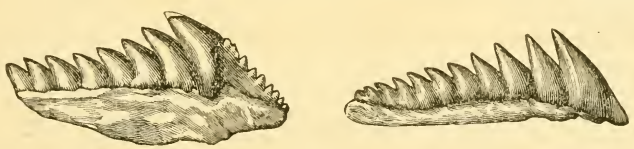

Fig. 16.—Teeth of *Notidanus gigas*, Red Crag, Suffolk.

nated with oxides of iron and manganese. The Sharks' teeth belong principally to species believed to be extinct, and resemble those found fossil in the late Tertiary formations.

The small *Scylliidæ* appear to be represented in the English Chalk by *Scylliodus*; and the living genus *Scyllium*, with some

Table-case, No. 27.

other forms, is discovered in a beautiful state of preservation in the Upper Cretaceous of Mount Lebanon.

Table-case, No. 27.

The *Notidanidæ* are an ancient family, represented by four or five species at the present day, and noteworthy both on account of the primitive character of their skull (Fig. 17), and for the possession of six or seven gill-clefts instead of the usual five. Teeth possibly referable to *Notidanus* itself have been recorded from the Lias, and several undoubted examples are known from the Oolites, in addition to complete fishes from the Lithographic Stone of Bavaria. The Chalk and Tertiary formations also yield numerous species, and it is noteworthy that the largest and most complete teeth are those of the latest deposits (Fig. 16).

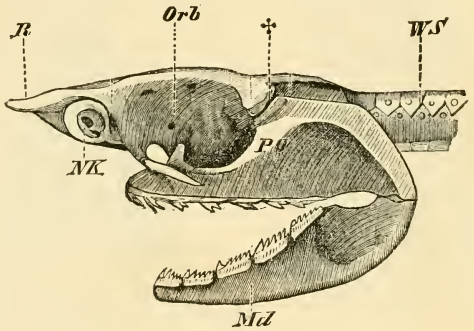

Fig. 17.—Skull of *Notidanus*, side view (after Wiedersheim).

pq. pterygo-quadrate cartilage (upper jaw); *md*. mandibular cartilage; *nk*. nasal capsule; *orb*. orbit; *r*. rostrum; *ws*. vertebral column, ✢ postorbital articulation of the upper jaw with the cranium.

Wall-case, No. 2.

Table-cases, Nos. 27, 28.

Of the extinct family of *Hybodontidæ*, a large series of specimens is exhibited, the finest from the Lower Lias of Lyme Regis and the Wealden of Pevensey Bay. The external form and the fins of these fishes are not yet known, but it is very likely that they had somewhat the proportions of the living *Cestracion* (Fig. 9). There are two dorsal fins, each armed in front with a strong spine (Fig. 18). The skin is often covered in part with a dense shagreen; and on each side of the head there is a pair of large barbed hooklets, fixed upon bony bases, which were originally regarded as teeth and named *Sphenonchus* by Agassiz. The skull is of a primitive type, much resembling that of *Notidanus*; and the teeth in some species are also very similar to the early forms of the last named genus. The precise limits of the generic type known as *Hybodus* have not yet been satisfactorily determined; but cuspidate crushing teeth much like those of the Lias are occasionally met with in the Coal-measures, and the latest species hitherto assigned to this form is the little *Hybodus dubrisiensis* of the Chalk. Fine examples of the nearly complete dentition are shown from the Lias of Lyme Regis, and also in the Wealden skulls from Pevensey Bay. The latter

have higher and sharper crowns than the former, and so likewise have the detached teeth from the Lower Oolites. The dorsal spines are all ornamented with longitudinal ribs, and the posterior is shorter and stouter than the anterior. *Orodus* is an old Hybodont of the Carboniferous Limestone.

The *Cestraciontidæ* follow the *Hybodontidæ*, and at least one of the genera—*Acrodus*—usually placed here, seems to pass almost imperceptibly into the true *Hybodus* of the preceding family. Its teeth (Fig. 20) are in most cases much less cuspidate than those of the Hybodonts, but at least some species have similar dermal "*Sphenonchi*" and ribbed dorsal spines. Table-case, No. 29.

Fig. 18.

Fig. 19.

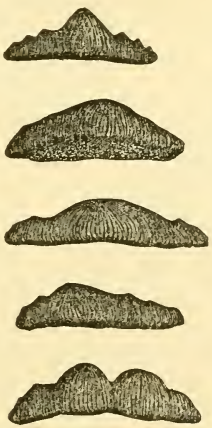

Fig. 20.

Fig. 18.—A, spine of *Lepracanthus Colei*, Owen, Coal-measures, Ruabon, N. Wales; B, a portion of the spine enlarged, to show the external ornamentation.
Fig. 19.—Teeth of *Acrodus Anningiæ*. Lower Lias, Lyme Regis.
Fig. 20.—Dorsal spine of *Hybodus*, Lias, Lyme Regis.

A single genus of this family, the *Cestracion* or "Port-Jackson Shark" (Figs. 9, 21, 22), still survives and throws most important light upon the detached fossil teeth which are so frequently met Table-case, No. 29.

with in strata of Cretaceous, Jurassic, and Carboniferous age. The dentition (Figs. 21, 22) shows it to be admirably fitted for the prehension and mastication of Crustacea and Mollusca. The teeth are arranged in oblique rows upon the cartilaginous jaws, and vary greatly in character between those forming the anterior series, which consists of sharp, pointed teeth modified for seizing and

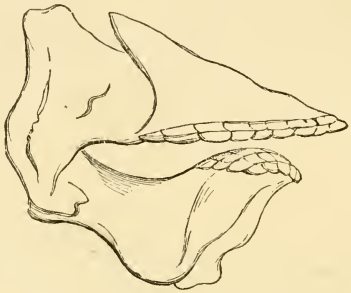

Fig. 21.—Side-view of jaws of Port-Jackson Shark, *Cestracion Philippi* (recent).

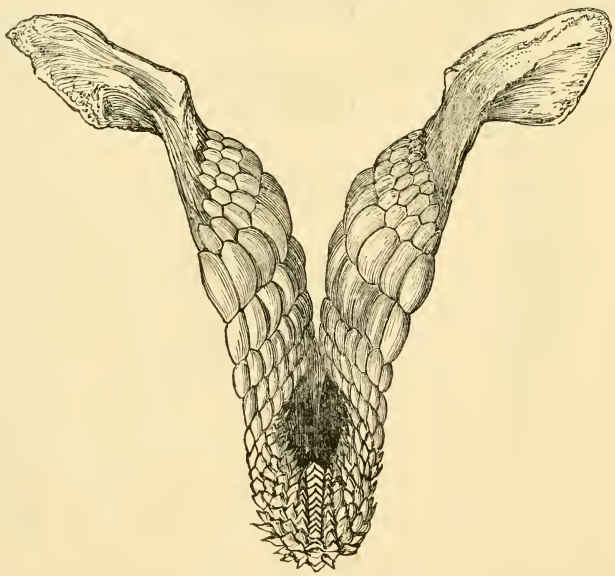

Fig. 22.—Jaw of Port-Jackson Shark, *Cestracion Philippi* (recent).

holding their prey, and the lateral series, which are well adapted by their flattened form for crushing shells. These lateral teeth also vary greatly in the several rows (Fig. 22) covering the two rami of each jaw, and they enable the palæontologist clearly to

understand that many so-called species founded on different forms of fossil crushing teeth found detached from one another, may, after all, have really belonged to different parts of the mouth of one and the same individual species of Shark.

The dentition of *Acrodus* differs from that of *Cestracion* mainly in the replacement of the numerous small symphysial teeth by two or three rows of large teeth, less pointed, as is shown by several Liassic fossils in the case. A nearly complete jaw of *Strophodus* (Fig. 23), from the Great Oolite of Caen, Normandy, proves that

Table-case, No. 29.

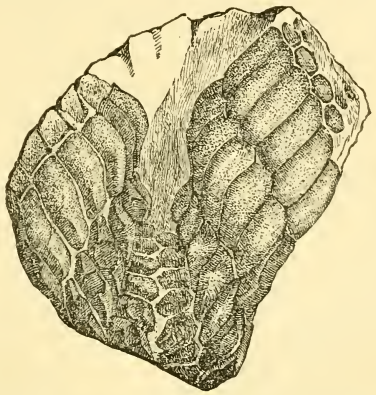

Fig. 23.—Jaw of *Strophodus medius*, Great Oolite, Caen, Normandy.

in this genus there was also a similar divergence from the surviving type. *Acrodus* ranges from the Muschelkalk to the Cretaceous inclusive, and *Strophodus* is Jurassic and Cretaceous; but in the latter formation it is difficult to distinguish both these genera from *Drepanephorus*, which is a characteristic Shark of the Chalk. The smooth dorsal spines of this fish were originally described by Agassiz as *Spinax*, and the genus was erroneously referred to the *Spinacidæ* by Egerton. *Wodnika*, from the Permian Kupferschiefer, is also perhaps an early Cestraciont.

The *Cochliodontidæ* are an interesting Carboniferous family known only by their dentition, which is arranged somewhat like that of *Cestracion*, but in which the several series of lateral teeth are each represented by a single plate, coiling inwards by growth at the outer edge. *Cochliodus* (Fig. 24) is the typical genus, and *Streblodus*, *Psephodus*, *Sandalodus*, *Pœcilodus*, etc., are very similar forms. Many of the teeth named *Helodus* almost certainly pertain to the symphysis of the jaw of these fishes; but *Helodus simplex*, from the Coal-measures, is a distinct genus.

Table-cases, Nos. 29, 30.

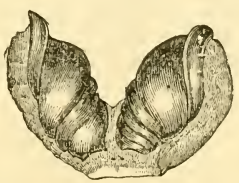

Fig. 24.—Teeth of *Cochliodus contortus*, Carboniferous Limestone, Armagh.

Wall-case, No. 3. Table-case, No. 30.

The *Spinacidæ* are represented by the living genus *Centrophorus* in the Cretaceous of Mount Lebanon; *Palæospinax*, from the English Lias, is also commonly placed with this family, though its position is very doubtful.

Wall-case, No. 3. Table-case, No. 30.

The *Squatinidæ*, or "Angel-fishes," resemble the Sharks in the lateral position of the gill-clefts, but have a depressed body like that of the Rays. The mouth is terminal and the teeth are sharply pointed. Nearly complete examples of the existing genus *Squatina* have been discovered in the Lithographic Stone (Upper Oolite) of Bavaria (Figs. 25, 26), and in the Chalk of Mount Lebanon and Westphalia. More fragmentary remains are also met with in the English Chalk and Tertiaries.

Fig. 25.

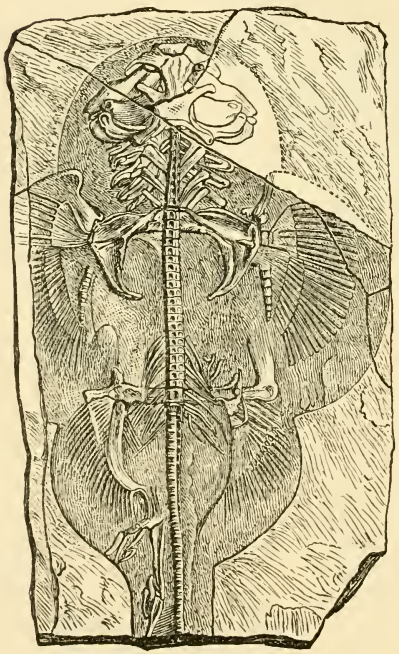

Fig. 26.

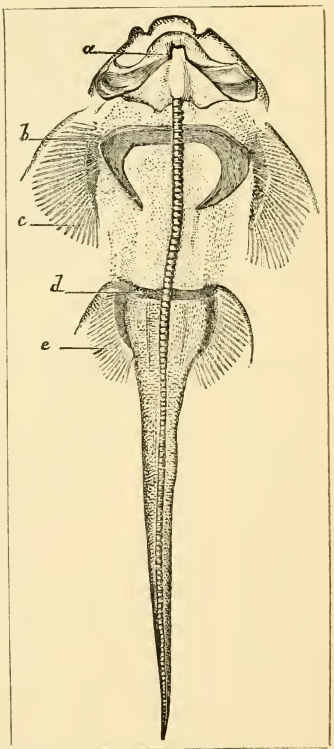

Fig. 25.—*Squatina alifera* (after Fraas), Lithographic Stone (Upper Oolite), Bavaria.
Fig. 26.—*Squatina speciosa*, Lithographic Stone (Upper Oolite), Bavaria.
a, mandibular cartilage; *b*, pectoral arch; *c*, pectoral fin; *d*, pelvic arch; *e*, pelvic fin.

Wall-case, No. 3.

Of the *Squalorajidæ*, from the Lias of Lyme Regis, several fine specimens are exhibited in the wall-case. *Squaloraja* seems to be allied in many respects to the living *Pristiophoridæ*, but has several

curious Chimæroid affinities: upon the long snout of the male is placed a slender prehensile spine (Fig. 11*f*), evidently homologous with that of male Chimæroids.

The *Petalodontidæ* comprise Carboniferous and Permian genera, of which little is known beyond the dentition. *Petalodus*, *Ctenoptychius*, *Petalorhynchus*, and *Polyrhizodus* are Carboniferous forms: and *Janassa* (Fig. 27), of which the dentition is very completely

Table-cases, Nos. 30, 31.

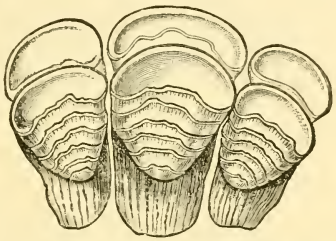

Fig. 27.—Some of the central teeth of *Janassa linguæformis*, posterior aspect, Coal-measures.

understood, is both Carboniferous and Permian. These fishes were evidently Rays.

The *Psammodontidæ* are a group of Plagiostomes known only by the detached teeth named *Psammodus*, so characteristic of the Lower Carboniferous. They were evidently fishes of depressed form, referable to the Rays; and the *Copodontidæ*, of this horizon, were also probably similar.

Table-case, No. 31.

The well-known teeth of *Ptychodus*, from the Chalk, belong to an uncertain family, but the specimens in the case show that the genus must have been a huge form of Ray.*

Table-case, No. 32.

Various Rays of a modern type have been discovered in the Upper Jurassic, Cretaceous, and Tertiary formations. The *Rhinobatidæ* are represented by *Spathobatis*, from the Lithographic Stone of Bavaria, and *Rhinobatus*, from the Cretaceous of Mount Lebanon. Of the *Pristidæ*, or "Saw-fishes," fragments of the toothed snout are shown from the English Eocenes. The "Sting-rays" (*Trygonidæ*) have an extinct representative, *Cyclobatis*, in the Chalk of Mount Lebanon. The *Rajidæ*, or Skates and Rays proper, have left their spinous dermal tubercles (Fig. 29) in the Pliocene Crags; and the great "Devil-fishes," "Sea-devils," and "Eagle-rays" (*Myliobatidæ*) are represented by numerous examples of their dentition, especially of *Myliobatis* and *Aetobatis*, from the Tertiaries.

Wall-case, No. 3.

Table-case, No. 33.

Table-case, No. 32.

The spines known as *Myriacanthus*, from the Lias, are also referred to an unknown family of Rays.

Wall-case, No. 3.

The *Pleuracanthidæ* are a most remarkable extinct family characteristic of the Carboniferous and Permian. As shown by nearly

Wall-case, No. 3.

* Some of the modern Rays are said to attain an enormous size, and to weigh many hundred pounds.

Table-case, No. 33.

complete specimens from the Permian of Germany, these fishes had a long barbed spine (named *Pleuracanthus* (Fig. 11*i*), *Orthacanthus*, or *Xenacanthus*) fixed immediately behind the head; the teeth were originally described as *Diplodus*, from the crown consisting of two main cusps; and there are distinct interspinous bones supporting the rays of the dorsal fin. *Cladodus* is also placed near this family.

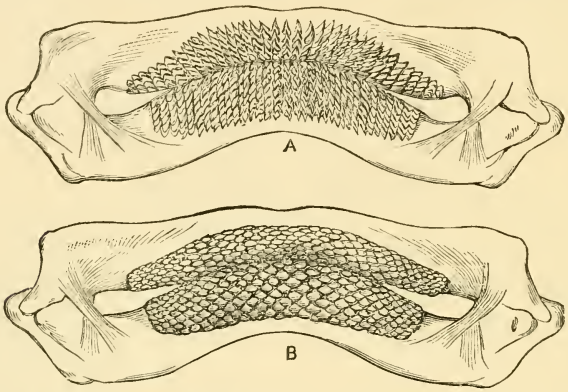

Fig. 28.—Jaws of Male (A) and of Female (B) Thornback Skate, *Raja clavata*, showing the remarkable variation in the dentition which they exhibit.

Fig. 29.—Dermal Spines of the Thornback, *Raja clavata*.

Order III.—CHIMÆROIDEI or HOLOCEPHALA.

The Chimæras resemble the Sharks in many important features, but, in the skull, the upper jaw is fused with the cranial cartilage, not suspended by the upper part of the hyoid arch. The skeleton is wholly cartilaginous, and the notochord is tolerably persistent, the vertebræ being represented by mere slender rings. In the two living genera, there is a strong spine in front of the dorsal fin: the gill-clefts are covered by a fold of skin, so that only a single external opening is observed: and the dentition consists of four plates above and two below.

Teeth of *Rhynchodus*, from the Devonian of North America, are

the earliest fossils referred to this order, but there are no examples in the collection. Numerous teeth of *Ganodus* occur in the Great Oolite of Stonesfield, near Oxford; *Metopacanthus* is Liassic; *Ischyodus* is known from the Jurassic, Gault, and Greensand; and

Wall-case, No. 3. Table-cases, Nos. 33, 34.

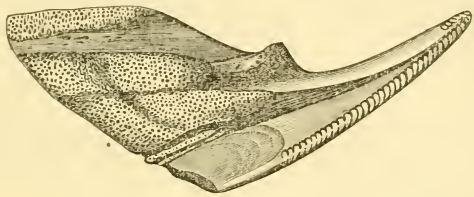

Fig. 30.—Lower Jaw of *Edaphodon leptognathus*, Middle Eocene, Bracklesham Bay, Sussex.

Edaphodon (Fig. 30) is Cretaceous and Eocene, while *Elasmodus* occurs only in the latter formation.

There can be no doubt that the spines known under the name of *Leptacanthus* pertain to the dorsal fins of these Chimæroids, being found in association with their teeth from the Lias to the Chalk.

PISCES INCERTÆ SEDIS.

Group I.—Acanthodini.*

The Acanthodians form an interesting group of very small or moderate-sized Palæozoic fishes characterized by the presence of strong defensive spines in front of the paired and median fins, but not in front of the caudal fin. They have minute rhombic

Wall-case, No. 4. Table-cases, Nos. 34, 35.

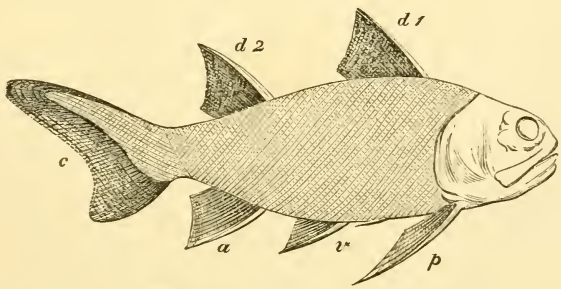

Fig. 31.—*Diplacanthus striatus*, Old Red, Cromarty.
d 1, first dorsal fin; *d* 2, second dorsal fin; *p*, pectoral fin; *v*, pelvic fin; *a*, anal fin; *c*, caudal fin. Each fin has a strong defensive spine in front.

* We have felt some doubt as to the propriety of placing the *Acanthodini*, the *Placodermata*, and the *Cephalaspidæ*, under the order Ganoidei: from the observations of Prof. Huxley, Dr. R. H. Traquair, and others, it seems quite probable that these ancient types of fishes, when better understood, may hereafter form more than one distinct order.

enamelled scales, ornamented in some species by fine striæ. From the similarity of form of the dorsal spines and their mode of implantation, the small and shagreen-like scales, which scarcely overlap, the cartilaginous skeleton, and naked branchial arches, they are considered by some ichthyologists to occupy a position intermediate between the *Plagiostomi* and the *Ganoidei.*

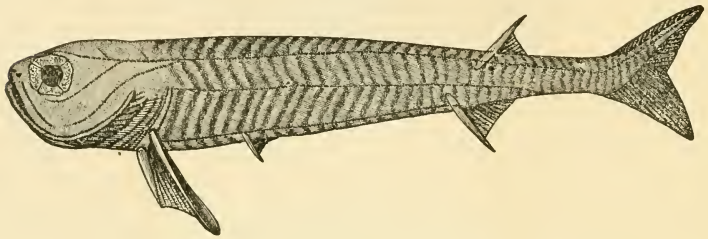

Fig. 32.—*Acanthodes*, sp. (restored figure, after Kner and Roemer), Permian.

They are represented by *Diplacanthus* (Fig. 31), *Cheiracanthus*, *Climatius*, *Euthacanthus*, and *Parexus*, from the Old Red Sandstone, and *Acanthodes* (Fig. 32), ranging from the Old Red to the Permian.

Group II.—Placodermata.

Wall-case, No. 4.

The *Placodermata* are characteristic of the Old Red Sandstone or Devonian rocks. The head and anterior portion of the body were covered with large bony plates, sculptured and ornamented with beads of enamel.

In the genus *Pterichthys* (Figs. 33 and 34) there are two peculiar arms, or anterior fins, articulated to the sides of the body, just behind the head; the tail is covered with scales, and supports the dorsal fin.

The gigantic *Asterolepis* seems to have been allied to *Pterichthys.*

In *Coccosteus* (Figs. 35 and 36) the tail was destitute of scales, but very distinct neural and hæmal spines are seen with interspinous bones, supporting a dorsal and anal fin; no vertebræ have been observed, so that the notochord must have been persistent.

Prof. Newberry has described a huge Placoderm (*Dinichthys*) from the Devonian of North America, the dentition of which greatly resembles that of the recent *Protopterus* (Fig. 37). Dr. Traquair is of opinion that the Placodermata may turn out to have been an aberrant group of *loricated Dipnoi*, while Prof. Cope has recently suggested that the *Pterichthyidæ*, at least, are not fishes, but an ancient order of Tunicates.

FIG. 33.

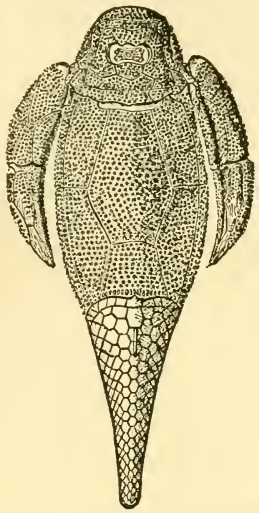

FIG. 34.

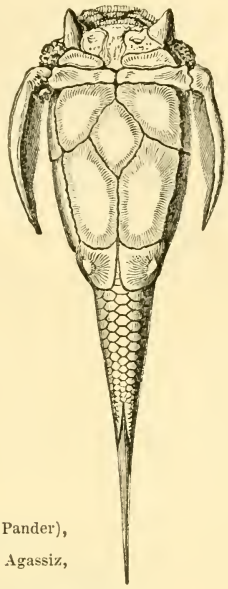

FIG. 33.—Dorsal surface of *Pterichthys Milleri* (after Pander), Old Red Sandstone, Scotland.
FIG. 34.—Ventral surface of *Pterichthys cornutus*, Agassiz, Old Red Sandstone, Scotland.

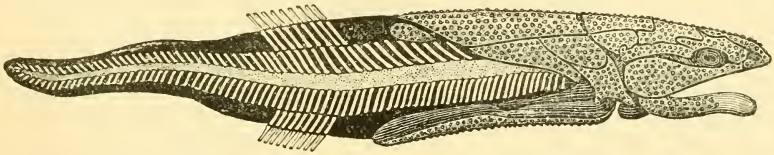

FIG. 35.—*Coccosteus* (side-view), Old Red Sandstone.

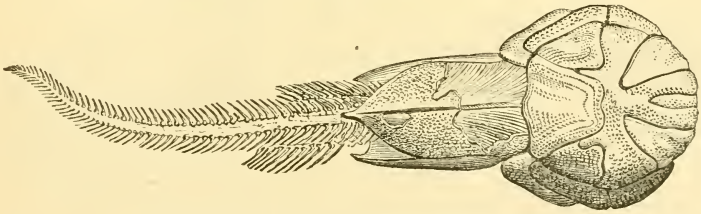

FIG. 36.—*Coccosteus decipiens* (dorsal aspect), Agassiz.

FIG. 37.—Jaws of *Dinichthys*, Devonian, North America.

Group III.—Cephalaspidæ.

Table-case, No. 35.

The *Cephalaspidæ* includes a peculiar and very ancient group of Palæozoic fishes, limited to the Upper Silurian and Old Red Sandstone.

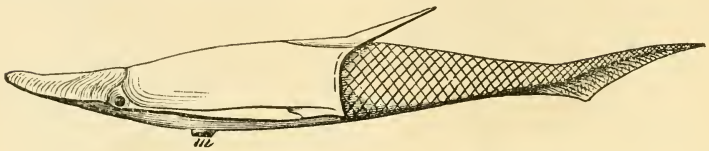

Fig. 38.—*Pteraspis* (restored), side view (after Lankester), Lower Old Red Sandstone, Herefordshire.

The earliest (*Scaphaspis ludensis*) is from the Lower Ludlow rock, near Ludlow, the oldest known fish. The head is covered with a large buckler composed of one or more pieces, a tail covered

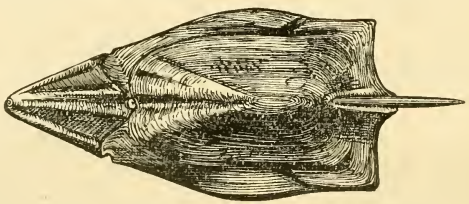

Fig. 39.—Restoration of shield of *Pteraspis*, upper aspect (after Lankester), Lower Old Red Sandstone, Herefordshire.

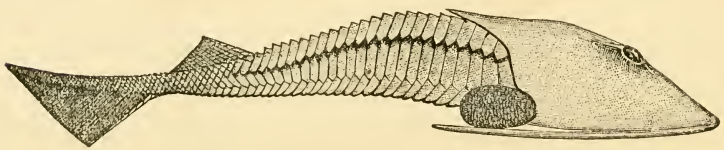

Fig. 40.—*Cephalaspis Lyelli* (restored), side-view (after Lankester), Old Red Sandstone, Forfarshire (drawn about one-third natural size).

with rhombic scales; but no internal skeleton of any kind has been met with.

They are divided into two groups; *Heterostraci*, which have no bone-cells in their shields, viz.:—*Scaphaspis*, *Pteraspis* (Figs. 38, 39), and *Cyathaspis*: and *Osteostraci*, viz.:—*Cephalaspis*, *Auchenaspis*, and *Eukeraspis*, in which bone-cells are present. Recent discoveries render it doubtful whether, in the Heterostraci, the genera *Scaphaspis* and *Pteraspis* are distinct; the first is perhaps the ventral shield of the second.

Cephalaspis Lyelli, from the Old Red of Forfar, is one of the most perfect of these older fishes. (*See* Figs. 40, 41.)

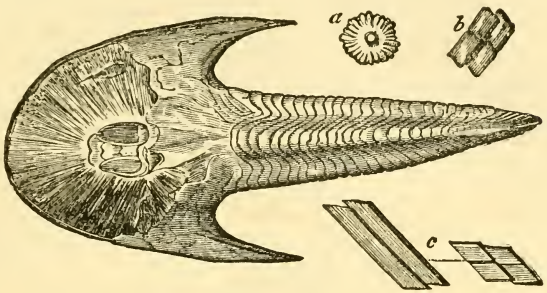

Fig. 41.—*Cephalaspis Lyelli* (dorsal aspect), from the Old Red Sandstone, Glammis, Forfarshire (about one-third the size of the original specimen). *a*, one of the peculiar tesseræ into which the middle layer of the shield is divided by the blood-vessels (drawn natural size); *b* and *c*, scales from different parts of the body and tail.

Order IV.—DIPNOI.

The *Dipnoi* (Table-case 36, and portion of Wall-case 5) form a very peculiar order, having three living representatives, namely, *Protopterus* in Africa (Fig. 47), *Lepidosiren* in South America, and *Ceratodus* in Australia (Fig. 42).

Wall-case, No. 5. Table-case, No. 36.

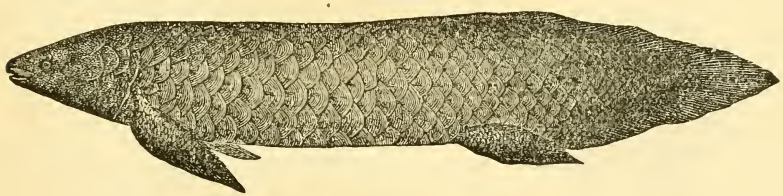

Fig. 42.—"The Australian Mudfish," *Ceratodus Forsteri* (recent), Australia.

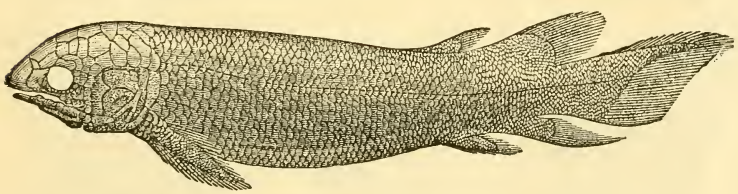

Fig. 43.—*Dipterus macrolepidotus*, Sedgw. and Murch., Old Red Sandstone, Scotland.

In these fishes the skeleton is notochordal, there are a pair of pterygo-palatine teeth, and a pair of incisor-like vomerine teeth above, and a third pair of teeth in the lower jaw (Fig. 44). There are two pairs of nostrils, more or less within the mouth, and the air-bladder, single or double, takes on the function of a lung. There is one

external branchial aperture into which the gills project freely, as in Ganoids and Teleosteans.

The caudal fin is diphycercal or heterocercal, the scales are cycloidal; the paired fins are acutely-lobate, with a central jointed cartilaginous stem fringed with radial cartilages and dermal fin-rays.

Table-case, No. 36.

Dipterus, from the Devonian rocks, has two dorsal fins, a heterocercal tail and one anal fin. The head is covered with bony ganoid plates, and the scales are also ganoid. (*See* Figs. 43, 45.)

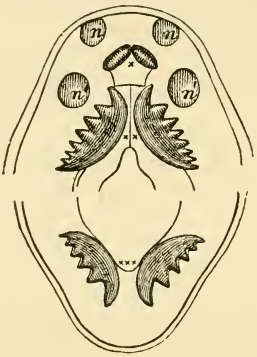

Fig. 44.—Mouth of *Ceratodus*. *nn*, narial openings; *x*, vomerine teeth; *xx*, palato-pterygoid teeth; *xxx*, mandibular teeth.

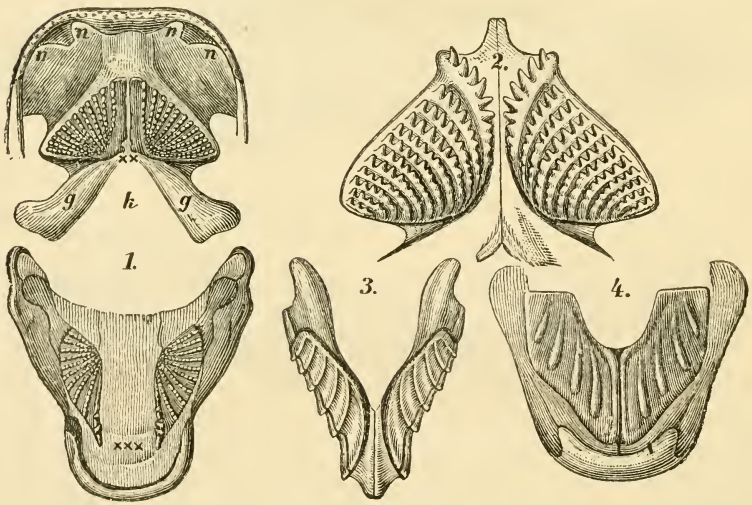

Fig. 45.—Jaws of Dipnoan Fishes; 1, upper and lower jaws of *Dipterus*; 2, 3, upper and lower jaws of *Ctenodus*; 4, upper jaw of *Palædaphus*.

Ctenodus, a common Carboniferous form, has bony head-plates like those of *Dipterus*, but the scales are thin and the tail probably diphycercal. Teeth indistinguishable in character from the modern

Ceratodus are abundant in the Trias and Rhætic. The other genera are *Palædaphus*, *Heliodus*, *Phaneropleuron* (Fig. 46), from the Old Red Sandstone, and *Uronemus*, *Ganopristodus*, from the Carboniferous rocks. (*See* Figs. 44, 45.)

Fig. 46.—Restoration of *Phaneropleuron* (after Traquair).

Order V.—GANOIDEI.*

The fishes of this order are, in most instances, covered with osseous ganoid scales or scutes—the pelvic fins are always abdominal.

The skeleton in some is notochordal, or cartilaginous, in others partially or completely ossified.

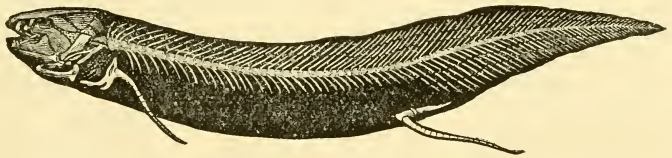

Fig. 47.—The African Mudfish, *Protopterus annectens*, living in the rivers of Africa.

Only one external gill-opening exists on each side, protected by a gill-cover.

Among living Ganoids there are four well-marked types :—

Suborder I.—Crossopterygidæ.

The *Crossopterygidæ*, which are represented by *Polypterus* (Fig. 48) and *Calamoichthys*, are confined to the rivers of tropical Africa (especially those of the West coast) and the Upper Nile.

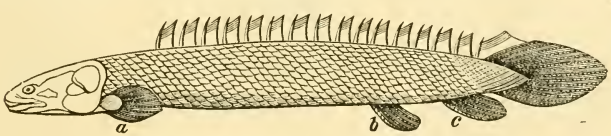

Fig. 48 —*Polypterus bichir*, living in the Nile, Gambia, etc.
a, pectoral fin ; *b*, pelvic fin ; *c*, anal fin.

* Three previously-noticed groups—*Acanthodini*, *Placodermata*, and *Cephalaspidæ*—are sometimes classed under the Ganoidei : from the remarks of Prof. Huxley, Dr. R. H. Traquair, Prof. E. D. Cope, and others, it seems quite probable that these ancient types of fishes may hereafter form more than one distinct order.

There is a long series of fossil forms from the Old Red Sandstone, and in later deposits, referred by Prof. Huxley to the *Crossopterygidæ*. The first are known as the *Holoptychiidæ*—having large rounded bony scales deeply imbricating and sculptured on

Wall-case, No. 5.

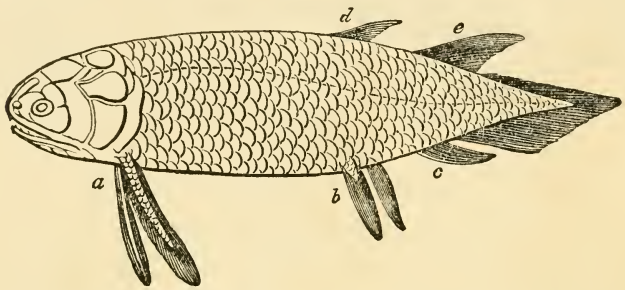

Fig. 49.—*Holoptychius*, Old Red Sandstone, Fifeshire (after Huxley). *a*, paired pectoral fins; *b*, pelvic fins; *c*, the anal fin; *d*, anterior dorsal fin; *e*, posterior dorsal fin.

their exposed surfaces. The skeleton is not known; most probably it was notochordal. They only occur in the Old Red Sandstone, and are represented by the genera *Glyptolepis* and *Holoptychius* (Fig. 49).

Wall-case, No. 5.

These are followed by the *Rhizodontidæ*, represented by *Tristichopterus* and *Gyroptychius* (Fig. 50) from the Old Red Sandstone, and *Rhizodus* from the Lower Carboniferous of Scotland; to these succeed the *Saurodipteridæ*, represented by *Osteolepis* (Fig. 51) and

Wall-case, No. 6.

Fig. 53.—Tooth of *Strepsodus*. (*See* Table-case, No. 36.)

Diplopterus, from the Old Red Sandstone; and *Megalichthys* from the Coal-measures.

Strikingly remarkable in this case are the remains of *Rhizodus Hibberti*, from Burdie House, the huge teeth and detached bones of the head of which led the earlier observers to refer it to the Labyrinthodonts; *Rhizodus* was probably the largest of Palæozoic fishes.

Wall-case, No. 6.

Lastly, the *Cœlacanthidæ*, remarkable, as a family of fishes, for

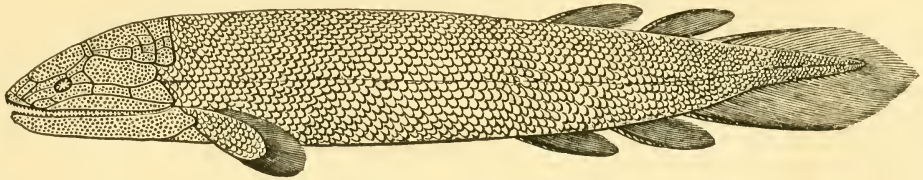

Fig. 50.—*Gyroptychius*, Old Red Sandstone, Scotland.

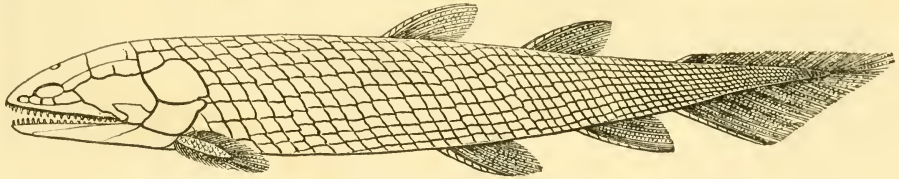

Fig. 51.—*Osteolepis* (restored outline after Pander), Old Red Sandstone, Scotland.

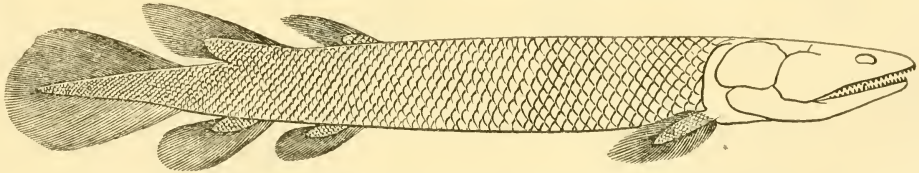

Fig. 52.—*Glyptolæmus Kinnairdii* (restored after Huxley), Old Red Sandstone, Scotland.

Figs. 50-52 admirably illustrate the passage from the true diphycercal tail in Fig. 52 to the heterocercal in Fig. 51.

Wall-case, No. 7.

their long range in geological time, *Cœlacanthus* occurring in the Coal-measures, the Permian and the Upper Oolite; *Holophagus* in the Lias, *Undina* in the Oolites (Fig. 54), and *Macropoma* in the Chalk formation (Fig. 55). The walls of the air-bladder appear to have been ossified in these fishes, as is well seen in several specimens of the series of *Macropoma*.

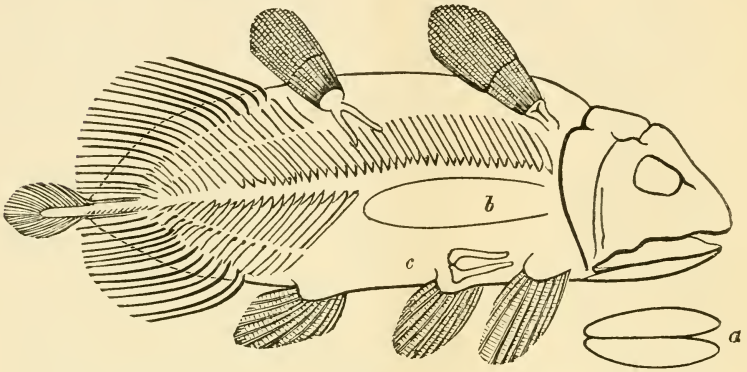

Fig. 54.—*Undina Kohleri*, Lias (restored outline after Huxley). *a*, jugular plates; *b*, the ossified air-bladder; *c*, the pelvic bones.

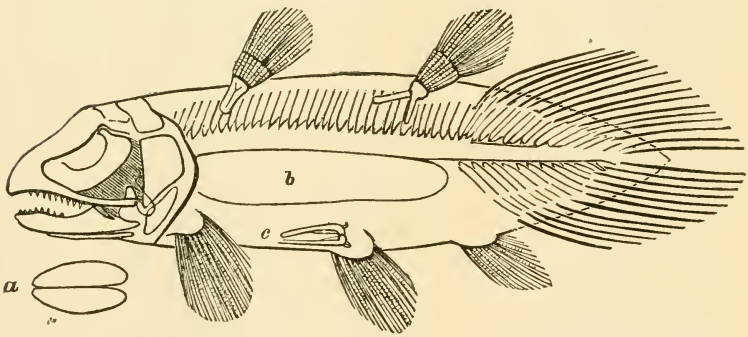

Fig. 55.—*Macropoma*, Chalk, Lewes (restored outline after Huxley). *a*, jugular plates; *b*, the ossified air-bladder; *c*, the pelvic bones.

Suborder II.—Acipenseroidei.

The *Acipenseroidei* are represented by *Acipenser*,* the Sturgeons, of which there are twenty species frequenting European, Asiatic, and American rivers. The skeleton in these fishes is notochordal; the skull is cartilaginous, with dermal ossifications and scutes.

* To this family also belong *Scaphirhynchus*, *Polyodon*, and *Psephurus*, found in the rivers of Asia and North America.

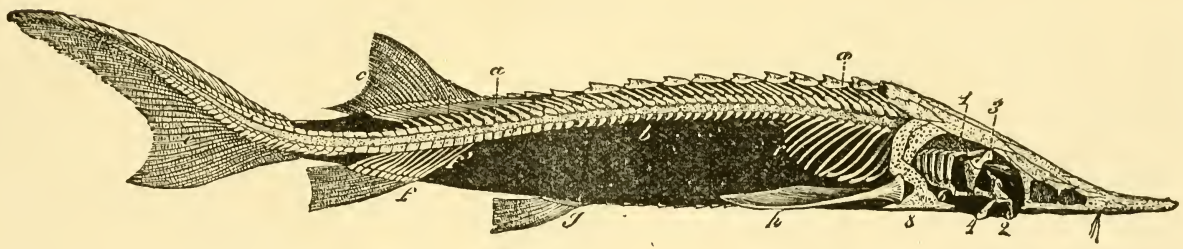

Fig. 56.—Skeleton of Sturgeon (*Acipenser*).

1, posterior extremity of cartilaginous cranium beneath the head-plates; 2, upper jaw; 3, hyomandibular bone; 4, lower jaw; 6, gill-arches; 8, pectoral arch; *a*, neural arches and spines, placed above the notochord; *b*, hæmal arches, placed below the notochord; *c*, dorsal fin; *e*, caudal fin; *f*, anal fin; *g*, pair of pelvic fins; *h*, pair of pectoral fins; *r*, ribs.

The fossil representatives of the *Acipenseroidei* are as follows:

Wall-case, No. 7.

Bony plates of *Acipenser* (Fig. 56) occur in the London Clay of Sheppey and in the Suffolk Crag.

The *Chondrosteidæ*, with a single genus, *Chondrosteus*, in the Lias of Lyme Regis, Dorsetshire (Fig. 62).

Wall-case, No. 8.

The *Palæoniscidæ*, in which the body is covered with rhombic, ganoid, and often beautifully sculptured scales, the caudal fin being completely heterocercal and Sturgeon-like.

Table-cases, Nos. 37 to 39.

One genus, *Cheirolepis*, remarkable for its very minute scales, is known from the Old Red Sandstone. The family attained its maximum in the Carboniferous formation, being represented by *Elonichthys*, *Rhadinichthys*, *Nematoptychius* and *Gonatodus*.

To these several new genera have been recently added from the Lower Carboniferous of Eskdale, Dumfriesshire.

Palæoniscidæ are also abundant in the Permian rocks both of England and the Continent (Fig. 61).

In the Magnesian Limestone of Durham we have *Pygopterus*, *Acrolepis*, and *Palæoniscus*; these also occur in the Kupferschiefer of Germany, and in the unteres-Rothliegendes *Amblypterus* (Fig. 57) and *Rhabdolepis* are found. In Fig. 57 are given views (*a*) of four

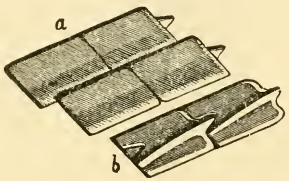

Fig. 57.—Ganoid scales of *Amblypterus striatus*, Carboniferous.

of the scales, showing the outer surface, and (*b*) of two of the scales, showing the inner surface. Each of the rhomboidal ganoid scales of *Amblypterus* has a ridge on the inner surface which is produced at one end into a projecting peg which fits into a notch in the next scale, reminding one of the manner in which tiles are pegged together on the roof of a house. The Triassic scales known as *Gyrolepis*, and the teeth named *Saurichthys*, probably both belong to a Palæoniscid fish (Traquair). In the English Lias are found *Oxygnathus*, *Cosmolepis*, and *Thrissonotus*. The *Palæoniscidæ* do not extend upwards beyond the Jurassic.

The *Platysomidæ* are most nearly related to the *Palæoniscidæ*. They are confined to the Carboniferous and Permian formations.

Wall-case, No. 8. Table-case, No. 39.

Platysomus (Fig. 58), *Eurynotus* (Fig. 59), *Wardichthys*, *Cheirodus* (*Amphicentrum*) (Fig. 60), *Mesolepis*, *Benedenius*, *Eurysomus*, are placed here, and perhaps also *Dorypterus*.

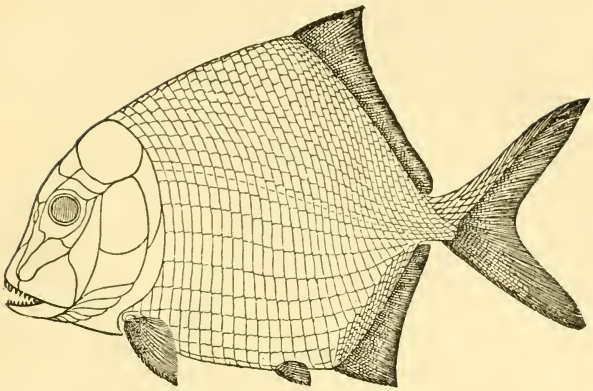

Fig. 58.—*Platysomus striatus*, Agassiz (restoration after Dr. R. H. Traquair), Magnesian Limestone.

Suborder III.—Lepidosteoidei.

The *Lepidosteoidei* are represented by *Lepidosteus*, the "Gar-pike," or "Bony-pike" of the rivers of North and Central America and Cuba: three species are living, having a completely ossified skeleton, the body being covered with stout rhombic ganoid scales.

Wall-cases, Nos. 9 to 15. Table-cases, Nos. 40 to 45.

The *Lepidosteoidei* were abundantly represented in Mesozoic times by a large series of fishes; embracing the *Sauridæ*, the *Lepidotidæ* (Fig. 63), the *Dapediidæ* or *Stylodontidæ* (Fig. 64),

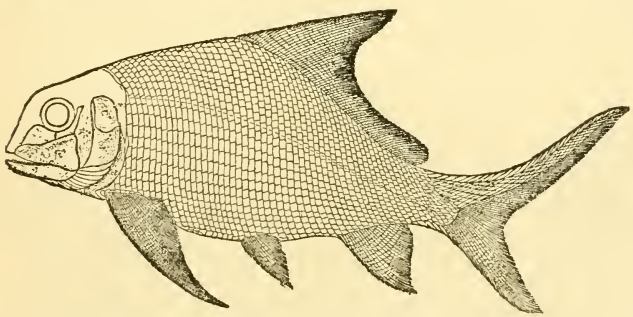

Fig. 59.—*Eurynotus crenatus*, Agassiz, "Cement-stones," Carboniferous Series of Scotland (after Traquair).

the *Aspidorhynchidæ*, and the *Pycnodontidæ* (Figs. 65–67); having rhombic ganoid scales and semi-heterocercal tails; the vertebræ were less ossified than in the recent *Lepidosteus*, and in all the notochord was more or less persistent. In the *Pycnodontidæ* the mouth was provided either with conical or flattened teeth arranged

Wall-case, No. 14. Table-cases, Nos. 44, 45.

in longitudinal rows, or with formidable pointed teeth, and large and small premaxillary teeth.

The dorsal and anal fins were long and opposite one another; the caudal fin equilobate externally, but the notochord very distinctly upturned at its termination.

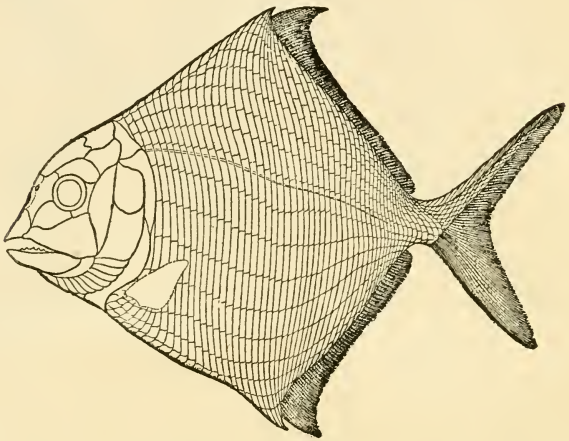

Fig. 60.—*Cheirodus granulosus*, Young (restoration after Traquair), Coal-measures.

Table-case, No. 40.

The Lepidosteoid fishes have a range in time from the Permian (*Acentrophorus*) to the present day. Among the genera represented are *Lepidotus* (Fig. 63), *Dapedius* (Fig. 64), *Tetragonolepis*, *Heterolepidotus*, *Pholidophorus*, *Pachycormus*, *Semionotus*, *Aspidorhynchus*, etc. (See Wall-cases 9–14; and Table-cases 40–45.)

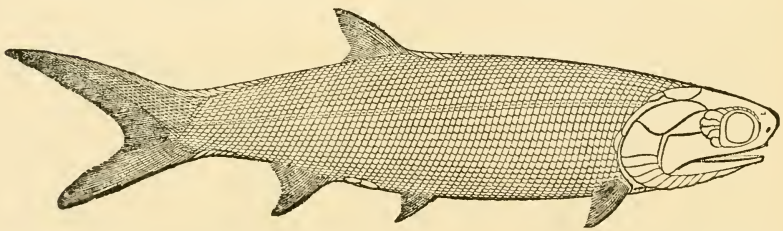

Fig. 61.—*Palæoniscus macropomus*, Ag. (from a restoration by Dr. R. H. Traquair), Kupferschiefer.

One of the largest of these is *Lepidotus maximus* (Fig. 63), from the Lithographic Stone of Solenhofen, in Bavaria, which measures 5 feet 7 inches in length, and is 2 feet in greatest depth.*

* A coloured cast of this great fish is placed over the centre doorway at the north end of this Gallery. The original is in the Munich Museum.

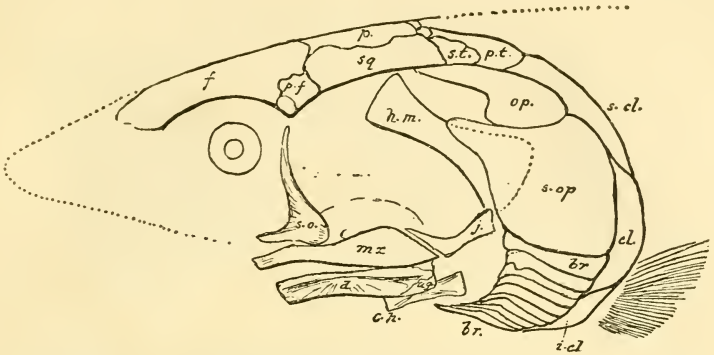

FIG. 62.—Restoration of Head of *Chondrostes acipenseroideus* (after Traquair), Lower Lias, Lyme Regis.

ag, angular bone; *br*, branchiostegal rays; *ch*, ceratohyal; *cl*, clavicle; *d*, dentary bone of mandible; *f*, frontal; *hm*, hyomandibular; *j*, jugal; *i.cl*, infraclavicle; *mx*, maxilla; *op*, operculum; *p*, parietal; *pf*, postfrontal; *pt*, post-temporal; *s.cl*, supraclavicle; *so*, suborbital; *s.op*, subopercular; *st*, supratemporal; *sq*, squamosal.

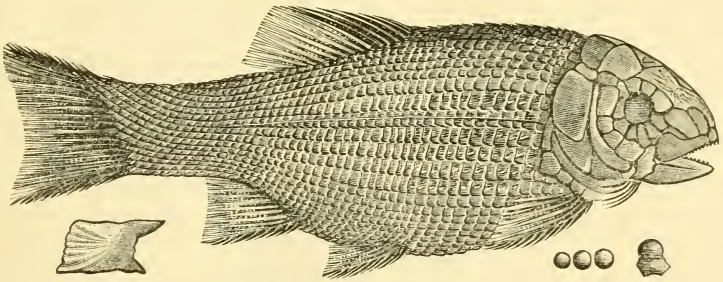

FIG. 63.—*Lepidotus maximus*, Lithographic Stone (Upper Oolite), Bavaria.

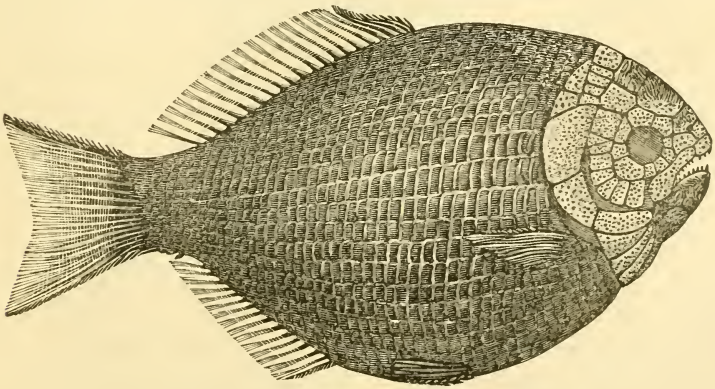

FIG. 64.—*Dapedius pholidotus*, Lower Lias, Lyme Regis, Dorset.

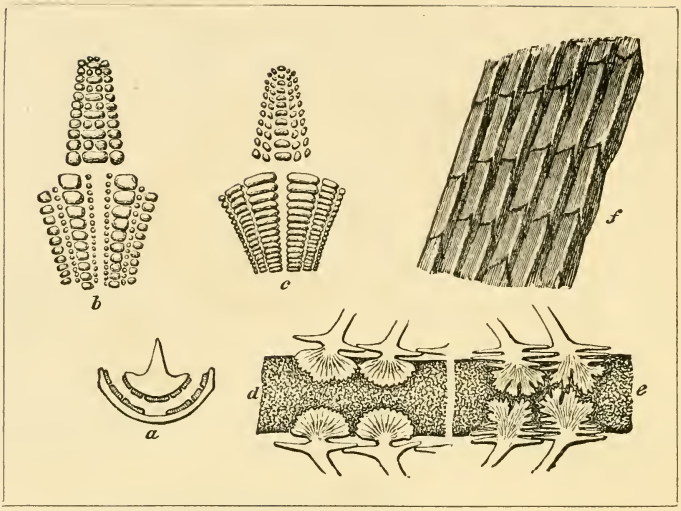

Fig. 65.—Portions of Pycnodonts. *a*, transverse section of jaws, showing the two halves of the mandibular dentition opposing the vomerine teeth; *b*, dentition of *Microdon*; *c*, dentition of *Cælodus*; *d*, portion of vertebral column of *Cælodus*, showing persistent notochord (shaded), and the expanded bases of the arches; *e*, the same of *Pycnodus*: *f*, inner view of scales, showing mode of interlocking by pegs and sockets, which are continued as longitudinal ribs.

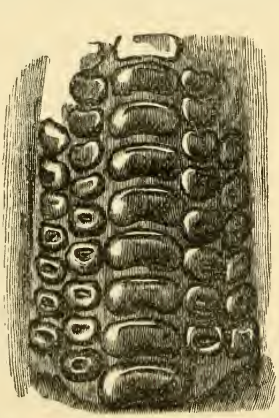

Fig. 66.—Upper dentition of *Cælodus ellipticus*, Gault, Folkestone.

Suborder IV.—Amioidei.

Wall-case, No. 15. Table-cases, Nos. 46 to 48.

The *Amioidei* are represented by the *Amia*, or "Bow-fin," of the United States fresh-waters.

In Wall-case 15, and Table-cases 46–48, are arranged

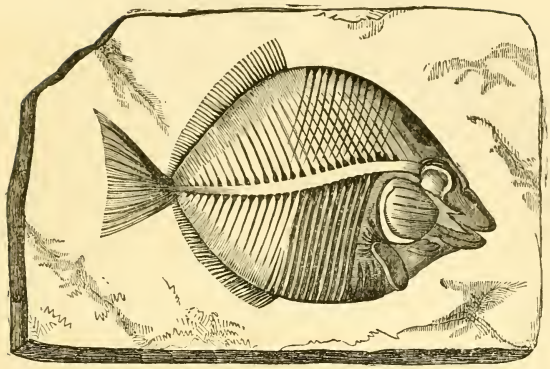

Fig. 67.—*Stemmatodus* (*Pycnodus*) *rhombus*, Oolite.

the fossil fishes referred to the *Amioidei*, *Leptolepis* (Fig. 69), *Thrissops*, *Megalurus*, *Oligopleurus*, from strata of Jurassic age.

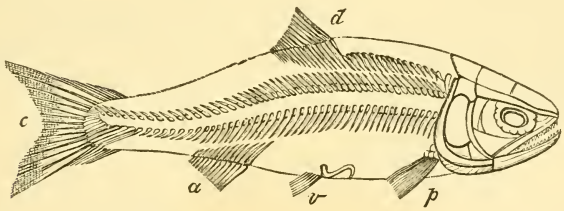

Fig. 68.—*Caturus furcatus*, Lithographic Stone, Upper White Jura, Solenhofen. *p*, pectoral fins; *v*, pelvic fins; *a*, the anal fin; *d*, dorsal fin; *c*, caudal fin. Just above *v* are seen the pelvic bones.

Protamia and *Hypamia*, from the Tertiary deposits of North America, are clearly allied to *Amia*: and so also, probably, is the genus *Cyclurus*, from the Miocene of France and Switzerland. Table-case, No. 48.

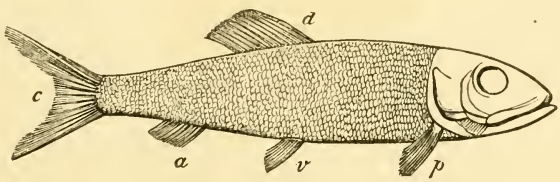

Fig. 69.—*Leptolepis sprattiformis*, Lithographic Stone, Solenhofen. *p*, pectoral fins; *v*, pelvic fins; *a*, anal fin; *d*, dorsal fin; *c*, caudal or tail-fin.

Order VI.—TELEOSTEI.

As already remarked, there are among the fishes of the Jurassic period, and especially the later portion of it, several genera having a remarkably Teleostean facies, so far as can be judged from their skeletal parts; and it is not unlikely that some of these might be correctly placed in this order. Unfortunately, however, the Teleostei mainly differ from the Ganoids in the structure of certain soft parts,—*e.g.* in the bulbus arteriosus of the heart being non-contractile, the intestine having no spiral valve, and the optic nerves decussating,—and the palæontologist is thus unable to recognize with certainty any members of the order that have not an obvious and intimate relationship to some known type still surviving.

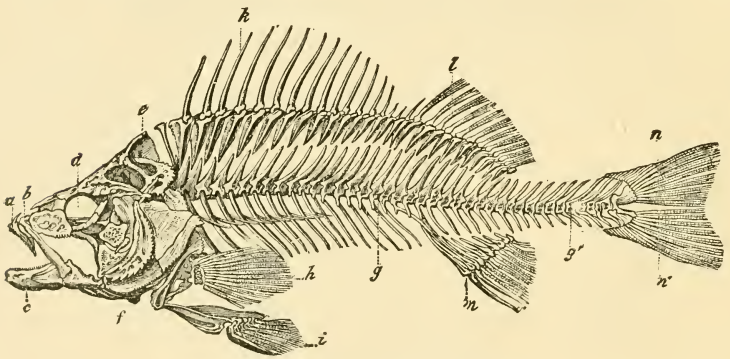

Fig. 70.—Skeleton of the Common Perch.

a, premaxillary bone; *b*, maxillary bone; *c*, lower jaw; *d*, palatine arch; *e*, cranium; *f*, interopercelum; *g g'*, vertebral column; *h*, pectoral fin; *i*, pelvic fin; *k*, spinous dorsal fin; *l*, soft dorsal fin; *m*, anal fin; *n*, upper, and *n'*, lower lobe of caudal fin.

[The pectoral and pelvic fins each form a pair, and correspond respectively to the anterior and posterior pairs of limbs of the higher Vertebrata. The dorsal, caudal, and anal fins are median and unpaired.]

For this reason the Teleostei are usually regarded as having their first representatives in strata of Cretaceous age, and here are discovered numerous forms allied both to the highest and lowest divisions of the group. There are Acanthopterygian (spiny-finned) fishes, in which a certain number of the anterior rays of the dorsal, anal, and pelvic fins, have already become stiffened into spines, and in which the pelvic fins have mostly advanced forwards to be placed beneath the pectorals; and there are also innumerable examples of the more primitive division of the order, the Physostomi, which have so far retained the characters of their Ganoid ancestry as to possess abdominal pelvic fins, few or no spinous rays, and the margin of the upper jaw very frequently formed in part both by the maxilla and the premaxilla.

Thus restricted, the fossil representatives of the Teleostei are

arranged in Table-cases 48–56 and Wall-cases 15–18, and the least specialized are placed first, while the highest and some aberrant forms close the series.

A B

Fig. 71.—Scales of Teleostean Fishes.
A, Cycloid; * B, Ctenoid.†

Suborder I.—Physostomi.

The *Physostomi* are so called from the usual persistence in them of the duct connecting the air-bladder with the œsophagus (gullet), which constitutes so conspicuous a feature in the Ganoids and Dipnoi, in which it helps to form the primitive "lung." They are also characterized, as just remarked, by the abdominal situation of the pelvic fins and the absence of all spinous rays, except the occasional single one in front of the pectorals and dorsal.

Wall-cases, Nos. 15, 16. Table-cases, Nos. 49 to 53.

The first family of importance is that of the *Salmonidæ*, which is considered to embrace, among other extinct forms, three genera from the English Chalk, *Osmeroides*, *Acrognathus*, and *Aulolepis*. The two latter are extremely rare, but the former is one of the most characteristic fishes of the period. There is a fine series in the table-case, including the type-specimens, many obtained from the collection of the late Dr. Mantell, and several beautifully worked out of the chalky matrix by this distinguished pioneer in palæontology. Those of *Osmeroides* are especially perfect, and, like most fossil fishes from the Chalk, they are almost uncompressed, the fine calcareous particles having replaced the muscular and other tissues as rapidly as they were destroyed by decomposition, thus preventing the collapse of the flanks, and preserving the natural rotundity and form of the fish when living.

Table-case, No. 49.

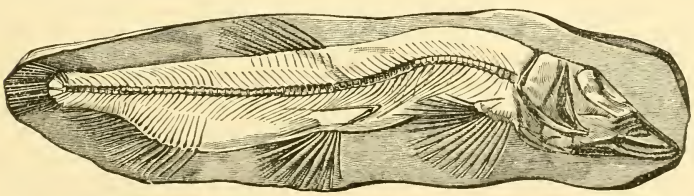

Fig. 72.—Capelin (*Mallotus villosus*) in nodule of Glacial Clay, Greenland.

Some closely allied fishes from the Eocene Slates of Glaris, Switzerland, and the Miocene of Licata, Sicily, are placed in the genus *Osmerus*, to which the living "Smelt" belongs. And the

* *Cycloid*, circular scales. † *Ctenoid*, having the margin toothed (comb-like).

Table-case, No. 49.

existing "Capelin" (*Mallotus villosus*) is also found fossilized in concretionary nodules in comparatively recent clays on the coast of Greenland (Fig. 72), in Norway, and on the banks of the Ottawa River in Lower Canada. Of the latter curious fossils, several examples are shown from these various localities. The shape of the nodule in each case is observed to correspond precisely with the contour of the enclosed fish, and the concretion is probably due to the escape of gases from the decomposing body leading to a concentration of mineral matter at the spot from the clay around it.

Wall-case, No. 15. Table-cases, Nos. 49 to 51.

As the *Clupeidæ*, or Herrings (Fig. 73), which succeed in the same table-case, have scarcely any notable point of difference from the Salmonidæ, beyond the absence of the little adipose fin, which is situated upon the hinder portion of the back in the latter family, it is almost impossible, when dealing with fossils, to determine the limits of the two series. The adipose fin is most rarely preserved, and Agassiz therefore originally proposed to group these families together for palæontological purposes under the name of *Halecidæ*. There are fine examples of *Sardinius* and *Sardinioides* from the Upper Chalk of Westphalia and Mount Lebanon occupying a thus doubtful position, and then follows an extensive collection of the extinct species of the true Herring (*Clupea*). The earliest of the latter are met with in Upper Cretaceous strata, and the beautiful specimens from Mount Lebanon show the skeletal characters of the genus in a remarkably distinct manner; observe, especially, the well-preserved series of large ridge-scales producing the sharp serrated edge of the abdomen.

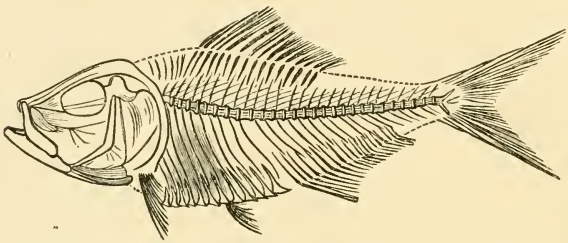

Fig. 73.—*Clupea brevissima* (after Pictet and Humbert), Upper Cretaceous, Mount Lebanon.

In the Syrian area, owing to some physical change in the conditions of the sea at the time the Cretaceous deposits were being laid down, these fishes appear to have been sometimes suddenly destroyed in shoals, and buried at once by the fine calcareous mud. This circumstance is well illustrated in the adjoining wall-case, by several slabs of fossil limestone from Hakel, near Beyrout, which are covered with hundreds of their remains. Tertiary species of *Clupea* are met with in the Eocenes of Monte Bolca, near Verona, in the Canton Glaris, Switzerland, and in the Miocenes of Ulm,

Wall-case, No. 15.

Würtemberg, and Licata, Sicily. *Alosa* occurs in the Infusorial Earth of Oran, Algeria. A closely-allied genus, *Diplomystus*, with anterior dorsal "ridge-scales," is also found in the Green River Shales of Wyoming, U.S.A., and is represented in the collection by several well-preserved specimens. *Scombroclupea* (with finlets behind the anal), *Rhinellus* (remarkable for its long snout, Fig. 74), *Spaniodon*, *Opistopteryx*, and *Leptosomus*, are other

Wall-case, No. 15.

Table-case, No. 51.

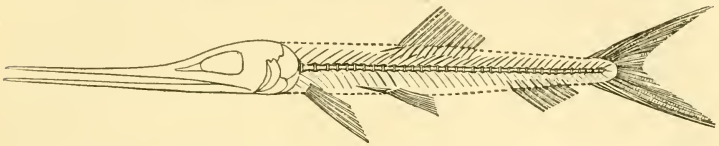

Fig. 74.—*Rhinellus furcatus* (after Pictet and Humbert), Upper Cretaceous, Mount Lebanon.

genera from the Cretaceous of Mount Lebanon. And in rocks of the same early period, both in the Old World and the New, there are numerous members of that remarkable section of the family which comprises the *Elops*, *Megalops*, and *Chanos*, of the existing fauna—a fact of considerable interest on account of the numerous points of resemblance to ganoids which these fishes exhibit. Such genera are *Thrissopater*, from the English Gault, *Halec*, *Elopopsis*, and *Protelops* from the Bohemian Chalk, and *Rhacolepis*, from the Upper Cretaceous of Brazil; also *Halecopsis* from the London Clay of Sheppey. *Platinx* occurs at Monte Bolca.

The large fishes of the extinct genus *Chirocentrites* from Mount Lebanon are also probably true Clupeoids.

The extinct Cretaceous family of *Hoplopleuridæ* follows next to the Herrings, and is characterized by the absence of true scales, which are replaced by scutes arranged along the back and sides in few symmetrical series. *Plinthophorus* and *Dercetis* occur in the Chalk of England; and *Dercetis* (*Leptotrachelus*) and *Eurypholis* (Fig. 75), are abundant in the Chalk of the Lebanon, from which

Table-case, No. 51.

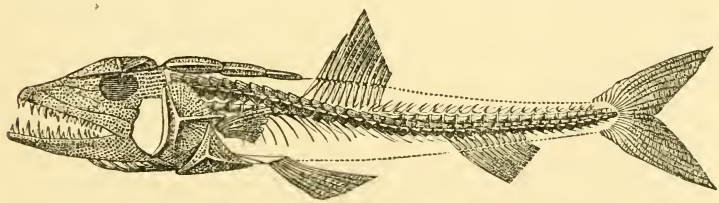

Fig. 75.—*Eurypholis Boissieri* (after Pictet and Humbert), Upper Cretaceous, Mount Lebanon.

locality a fine series in almost perfect preservation may be seen in the cases. The genera *Pelargorhynchus* and *Ischyrocephalus* are from the Cretaceous of Westphalia, and *Saurorhamphus* from the Chalk of Comen, Istria.

Wall-case, No. 16. Table-case, No. 50a.

Next to the *Hoplopleuridæ* are provisionally placed an extensive series of extinct fishes from the Chalk, which constitute the families of *Saurodontidæ*, *Stratodontidæ*, and *Erisichtheidæ* (*Protosphyrænidæ*) of Prof. Cope. These are regarded as truly Physostomous Teleosteans, though exhibiting some points of resemblance to the Acanthopterygii, and their natural arrangement is at present most uncertain, on account of the fragmentary character of the specimens hitherto exhaustively studied. To the *Saurodontidæ* are referred several genera with teeth implanted in distinct sockets, such as *Portheus*, *Daptinus*, *Ichthyodectes*, and *Saurocephalus*. Of the *Stratodontidæ*, *Pachyrhizodus* (=*Hypsodon* in part) and *Stratodus* are typical genera, and a fine series of specimens of the first is exhibited from the English Chalk. *Enchodus* is also placed here by Cope, but seems to represent a distinct family; the maxilla and premaxilla are very long and slender, with minute teeth, and the palatine and ectopterygoid are provided with powerful teeth; the palatine is especially robust, bearing a single large tooth, and forms one of the best-known Chalk fossils. *Cimolichthys* and *Pomognathus* may perhaps be closely allied genera, and many specimens are exhibited from the English Chalk. The *Protosphyrænidæ* are long-snouted fishes, with teeth implanted in distinct sockets, and with an unusually complex lower jaw. The detached teeth of *Protosphyræna ferox* (*Erisichthe Dixoni*) were originally referred in error to *Saurocephalus lanciformis*.

Table-case, No. 51.

The East Indian *Notopteridæ* are represented by a single species of *Notopterus* from the Tertiary lignites of Padang, Sumatra.

Table-case, No. 52.

The "Eels," or *Murænidæ*, are spread at present over almost all the freshwaters and seas of the temperate and tropical zones, and the earliest of their fossil remains hitherto discovered are from the Upper Cretaceous of Mount Lebanon. Beautiful examples of these are exhibited in the case. The genus *Rhynchorhinus*, of the London Clay, seems to be rightly placed in this family; and in the beds of Monte Bolca there are representatives of the living genera *Anguilla*, *Ophichthys*, and *Sphagebranchus*, in addition to numerous specimens of the so-called *Leptocephali*, which are supposed to be undeveloped larval forms. Later deposits, like the Miocene of Oeningen, Switzerland, and the Upper Eocene of Aix in Provence, France, have also yielded species of *Anguilla*, and some fine examples from the first-named locality are preserved in the collection.

Table-case, No. 52.

The *Cyprinodontidæ* (toothed Carps) are a family of very small freshwater fishes allied to the true *Cyprinidæ*, but differing, as the name implies, in the presence of teeth in the jaws, and also in one or two other important respects. Most of the fossil species appear to be referable to the living genus *Cyprinodon* (*Lebias*), and numerous specimens are shown from the Upper Eocene deposits of Aix in Provence, the Miocene of Oeningen, and the equivalent lignites of Central France and Germany. The fishes from Aix are frequently found buried in shoals, as is well shown by slabs of marl covered

with their remains exhibited in the case. Very singular is the occurrence of the genus *Pœcilia* in the Oeningen beds, this being now confined to the freshwaters of Tropical America.

The *Cyprinidæ* are found abundantly in a fossil state, but almost all the extinct species are referable to existing genera. The true Carp (*Cyprinus*) and Gudgeon (*Gobio*) occur in the Miocene of Oeningen. Species of *Leuciscus* (Roach, Dace, Minnow, etc.) are represented in the same deposit, in the lignites of France and Germany, and in the Upper Miocene Infusorial Earth of Licata, Sicily. The latter formation also yields remains of other genera, *e.g. Rhodeus* and *Aspius;* and as Herrings, Scopeloids, etc., occur abundantly in association with these, the mingling of marine and freshwater fishes is here very remarkable. The Tench (*Tinca*) is found in the Oeningen beds and Tertiary lignites; and the little *Acanthopsis*, now of Tropical India, is met with in the Miocenes of the Puy-de-Dôme, France. Other genera exhibited are *Barbus*, *Thynnichthys*, *Amblypharyngodon* and *Hexapsephus*, from the Eocene of Padang, in Sumatra; also *Cobitis* from Oeningen.

Wall-case, No. 16. Table-case, No. 52.

Of the *Esocidæ*, or Pike-family, few undoubted extinct forms have yet been discovered. The *Istiæus* of the Westphalian Chalk is sometimes placed here, but the earliest genus having a decided resemblance to the surviving type is the *Sphenolepis*, with long, wedge-like scales, from the Eocene Gypsum of Montmartre, Paris, and corresponding or slightly higher beds at Aix in Provence. Fine specimens of true Pike are shown from the Miocene of Oeningen; and there are fragments of the existing species (*Esox lucius*) from the peat of the Fenland.

Wall-case, No. 16.

The *Scopelidæ* are exclusively marine pelagic or deep-sea fishes, and but few fossil forms are known. They are represented in the collection by *Parascopelus* and *Anapterus* from the Upper Miocene of Licata, Sicily: and a still earlier genus, *Hemisaurida*, allied to *Saurus*, has been described from the Chalk of Comen, Istria.

Table-case, No. 53.

The remarkable family of *Siluridæ*, or "Cat-fishes," is widely distributed throughout most of the freshwaters, and some of the littoral areas, in all temperate and tropical regions at the present day; but fossil remains are much more rarely met with, than might be expected from the position these fishes occupy among living Teleosteans. They are characterized by the absence of scales, and the occasional presence of bony scutes, which sometimes envelope the entire body. The maxillary bone is almost always small, supporting a maxillary barbel; and the anterior dorsal and pectoral fins are often armed in front with a large, bony, denticulated spine. A posterior adipose dorsal fin of considerable size is also met with in many genera.

Table-case, No. 53.

No undoubted Cretaceous genera have been discovered, and the earliest known member of the family is *Bucklandium diluvii*, from the London Clay of Sheppey.

The Middle Eocene of Bracklesham yields evidence of one species indistinguishable from the living *Arius*—*Arius Egertoni*.

Remains of several other forms from the Siwalik Hills, India, and the highlands of Padang, Sumatra, are exhibited; these being mostly allied to species still living in those regions. Still more fragmentary fossils have been described from the Tertiaries of North America.

Suborder II.—Anacanthini.

This suborder, which comprises the symmetrically-formed Cod-fishes (*Gadoidei*) and the remarkably unsymmetrical Flat-fishes (*Pleuronectoidei*), is not known to have many representatives in the fossil state. None of the fins have spinous rays (hence the name); the median fins are almost invariably well developed; and the pelvic fins, when present, have either a thoracic or jugular situation.

Wall-case, No. 17.

Nemopteryx and *Palæogadus* are Gadoids from the black slates of Glaris; other undescribed forms occur in the London Clay of Sheppey; and a small recent *Gadus* is shown in a nodule from Glacial Clay, Bindalen, Norway.

Table-case, No. 53.

The "Flat-fishes" are characterized, except in the very young state, by the peculiar habit of constantly swimming and resting upon one side, the fore part of the head, with both eyes, becoming gradually twisted to the upper or opposite side in the adult. Species equally modified or "specialized" are met with even in the Eocene of Monte Bolca, where the living *Rhombus* occurs; and there are small kinds of "Sole" (*Solea*) in the Miocene of Ulm, Würtemberg; it is remarkable, however, that no less-altered ancestral types have hitherto been recognized.

Suborder III.—Pharyngognathi.

This is a group of spiny-finned fishes characterized by the coalescence of their two lower pharyngeal bones, which support a powerful dentition.

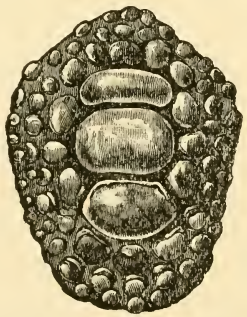

Fig. 76.—Pharyngeal dentition of *Phyllodus petiolatus*, London Clay, Sheppey.

Table-case, No. 53.

The true "Wrasses" (*Labrus*) appear to be represented in the Eocene of Monte Bolca, and an extinct family, the *Pharyngodopilidæ*, is indicated by some pharyngeal dental plates from the London

Clay of Sheppey and the Lower Tertiaries of the Continent. To the latter belong *Phyllodus* (Fig. 76) and *Pharyngodopilus* (*Nummopalatus*), and of the first-named genus the collection now comprises nearly all the type-specimens described in Prof. Cocchi's Monograph on these fishes. *Phyllodus* is so called on account of the leaf-like shape of the entire pharyngeal dentition, and the separate teeth composing this are very thin and constantly replaced by vertical successors, which are arranged in little piles beneath the functional ones. Table-case, No. 53.

The remarkable fragments of dentition from the London Clay, known as *Egertonia*, and those from the Bracklesham Beds termed *Platylæmus*, are also supposed to be referable to extinct Pharyngognathi. *Taurinichthys*, from the French Miocene, is also placed here.

Suborder IV.—Acanthopterygii.

The Acanthopterygians are characterized, as their name denotes, by the almost invariably spinous character of a number of the rays in the front part of the dorsal fin, and generally in the pelvic and anal fins. Nearly all, moreover, have the pelvic fins situated very far forwards, so as to become "thoracic." The air-bladder, when present, is not connected by an open duct with the gullet, in the adult. Wall-cases, Nos. 16 to 18. Table-cases, Nos. 53 to 56.

This suborder is divided into a great number of families, and all the more important appear to be represented in the fossil state.

The Indian freshwater *Ophiocephalidæ* are discovered in the Siwalik strata of that country. Table-case, No. 53.

The *Fistulariidæ*, or "Flute-mouths," which have been aptly described as "gigantic marine sticklebacks," are first known from the Eocene formation. Fossil remains of the two living genera, *Fistularia* and *Aulostoma*, occur at Monte Bolca and in the Slates of Canton Glaris; and *Auliscops*, another existing form, has been found at Padang, in the Tertiary Lignites of the Island of Sumatra. The Monte Bolca deposits also yield two extinct genera, *Urosphen* and *Rhamphosus*: the latter has an immense spinous ray, denticulated behind, inserted on the nape, well shown in the specimen in the case.

The *Mugilidæ* ("Grey Mullets") are represented by *Mugil* itself in the Upper Eocene of Aix in Provence; and the closely-allied *Atherinidæ* in the corresponding beds of Monte Bolca, by *Mesogaster*.

The great voracious "Barracudas" (*Sphyrænidæ*) of the West Indies and other tropical seas have small representatives at Monte Bolca. It is quite possible, too, that *Cladocyclus*, with large cycloid scales, from the Brazilian and European Cretaceous, is rightly associated with the same family. Table-case, No. 53.

Pterygocephalus, from the Eocene of Monte Bolca, seems to represent the "Blennies" (*Blenniidæ*): extinct species of "Gobies" (*Gobiidæ*) are also found in the same formation, and in the Infusorial Earth of Oran, Algeria.

Table-case, No. 54.

Petalopteryx, with huge pectoral fins, from the Cretaceous of Mount Lebanon, is perhaps an old "Flying-fish"—one of the *Cataphracti*. And the closely-allied "Millers' Thumbs" and "Gurnards" (*Cottidæ*) are represented in the Middle Tertiaries. *Lepidocottus*, almost identical with the living *Cottus*, except in possessing a covering of scales, is found in the Miocene of the Puy-de-Dôme, France; and a large series of these fishes is exhibited.

Remains of true "Angler-fishes" (*Lophius*) have been discovered at Monte Bolca; and the *Trachinidæ* ("Stare-gazers," etc.) may possibly be represented by *Callipteryx* from the same locality. To the latter also certainly belong *Trachinopsis* from the Upper Tertiary of Lorca, Spain, and *Pseudoeleginus* from the Upper Miocene of Licata, Sicily.

Wall-case, No. 16. Table-case, No. 54.

The *Scombridæ*—or Mackerel family—occur fossil in various Tertiary deposits. They may often be readily distinguished by the curious series of finlets, in most cases present behind the second dorsal and anal fins.

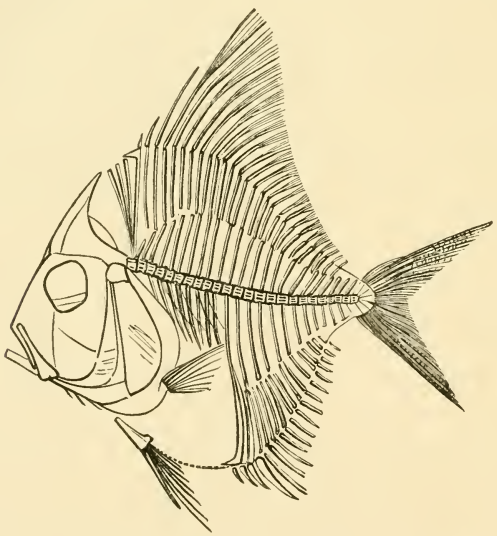

Fig. 77.—*Platax minor* (after Pictet and Humbert), Upper Cretaceous, Mount Lebanon.

The "Tunny" (*Thynnus*) and an extinct genus, *Orcynus*, are met with at Monte Bolca: remains of *Cybium* are not uncommon in the London Clay: and three other extinct genera, *Archæus*, *Isurus*, and *Palimphyes*, occur in the black Eocene Slates of Canton Glaris, Switzerland. Dr. Wettstein has also recently discovered the well-known "Remora" (*Echeneis*) in the latter formation—a fact of great biological interest. This fish has the anterior dorsal fin transformed into an oval sucking disc, by which it is enabled to attach itself to larger swiftly-swimming fishes and whales and dolphins; and this

modification seems to have been as complete in its early Tertiary progenitor as in the surviving type.

To the *Coryphænidæ*—pelagic fishes with a single long dorsal fin and laterally-compressed body—Dr. Günther refers the *Gasteronemus* of Monte Bolca, which is perhaps not distinct from the living genus *Mene*. It is remarkable for the length of the spinous rays representing the pelvic fins, and several fine specimens are exhibited in the wall-case. *Goniognathus*, from Sheppey, may also be placed here. Wall-case, No. 17.

The *Carangidæ*, or "Horse-mackerels," constitute an extensive family of laterally-compressed deep-bodied fishes, abundantly represented at present and throughout the Tertiary period, comprising a few forms also in the Cretaceous. *Vomer*, *Aipichthys*, and *Platax*, have been described from the Chalk of Comen in Istria (Trieste), and *Platax* (Fig. 77) alone from that of Mount Lebanon: the last-named genus survives in existing seas (as the "Sea-bats"), having also left traces of its presence in the Eocene of Monte Bolca, and the Crags of our Eastern counties. The Crag fossils are mere fragments of vertebral centra, neural spines, and interspinous bones; the spines are tumid in the middle, giving the broken pieces a curious appearance. *Semiophorus* (Fig. 78) is a remarkable extinct genus found at Monte Bolca, and characterized by the enormous development of the dorsal fin; the pelvic fins are long and slender, thoracic in position, and situated in advance of the pectorals, which are very small. *Lichia*, *Carangopsis*, and *Ductor*, are other Monte Bolca genera shown in the wall-case; the first still exists, the second is scarcely distinguishable from the living *Caranx*, and the third appears to be extinct. *Amphistium*, from the same deposit and the Paris Eocenes, is another form referable to this family. Wall-case, No. 17. Table-case, No. 51.

Of the *Acronuridæ*, or "Surgeons," species pertaining to the living *Acanthurus* and *Naseus* are exhibited from the Eocene of Monte Bolca. Table-case, No. 54.

An extinct family, apparently most closely related to the *Trichiuridæ*, is that of the *Palæorhynchidæ*. These are long, slender, laterally-compressed fishes, with a very delicate skeleton, and having the jaws prolonged into a sharply-pointed beak, either edentulous or provided with very small teeth. The dorsal fin is supported by spinous rays and extends along the entire length of the back, and the caudal fin is deeply forked. In *Palæorhynchum* the jaws are of equal length, and an extensive series of specimens is shown in the Wall-case, from the Eocene Slates of Canton Glaris. *Hemirhynchus*, which has the upper jaw much longer than the lower, occurs both in the Glaris beds and in the Lower Tertiaries of France and Belgium. Wall-case, No. 17.

The *Trichiuridæ* ("Hair-tails," "Scabbard-fishes," etc.) differ most prominently from the preceding family in the powerful character of the jaws, which are armed with strong teeth, some usually much larger than the others. Representatives of the existing *Lepidopus* occur in the Eocene Slates of Glaris, and also in Wall-case, No. 17.

Wall-case, No. 17.

the Upper Miocene of Licata, Sicily. Owing to imperfections in the specimens, the former were originally placed in a distinct genus, *Anenchelum*, and the distortion of the fossils led to an undue multiplication of the so-called species.

Hemithyrsites and *Trichiurichthys* are scaly extinct forms from the Upper Miocene of Licata, Sicily, but there are no examples in the collection.

Fig. 78.—*Semiophorus velicans*, Agassiz, from the Eocene formation of Monte Bolca. A, anal fin; C, caudal, D, dorsal; P, pectoral; V, pelvic fins.

Table-case, No. 55.

Next to the *Trichiuridæ* are arranged the fragmentary remains of *Xiphiidæ* or "Sword-fishes." These, as is well known, are remarkable for the great length of the cuneiform snout; they are the largest of Acanthopterygian Fishes. The generic determinations of the fossil forms are still very doubtful. Agassiz

originally referred to the existing *Tetrapterus* (*Histiophorus*) certain fragments of snouts from the Chalk, which now appear to be identical with those of a distinct Cretaceous family subsequently discovered—that of the *Protosphyrænidæ*. An extinct genus, *Cœlorhynchus*, was also founded upon some extremely slender, longitudinally-ribbed fossils, from the Chalk and Eocene formations, at first supposed to be the snouts of Sword-fishes; but Prof. W. C. Williamson has examined the microscopical structure of these, and regards them as dermal spines. To *Tetrapterus* (or *Histiophorus*) Agassiz also assigned fossil snouts and vertebræ from the Eocene Tertiaries, and the genera *Brachyrhynchus* and *Xiphiorhynchus* have since been founded upon Eocene and Crag fossils in Belgium.

Of the family of *Berycidæ*, a very large series of specimens is exhibited. These Fishes have much the general appearance of the Perches, but there are large cavities in the head-bones connected with the sensory slime-canal system, and the pelvic fins have (except in one genus) more than five soft rays in addition to the spine. They are all marine. The living genus *Beryx* occurs both in the English Chalk and the Upper Cretaceous of Mount Lebanon. Many of the English examples, both of this and allied genera, are but slightly compressed, retaining their original form, and those from the collection of the late Dr. Mantell are especially fine; several are the type-specimens figured in the works of Agassiz and Mantell; and later acquisitions from Mr. Frederic Dixon's collection are the originals of figures in his well-known "Geology and Fossils of Sussex." *Hoplopteryx* is a genus with very powerful fin-spines, to which are referred the two English Chalk species commonly known as *Beryx ornatus* and *Beryx superbus*, besides other forms from the Cretaceous of Westphalia and Mount Lebanon. *Berycopsis* (with cycloid scales), *Homonotus*, and *Stenostoma* are other genera of the English Chalk. *Pseudoberyx* (with almost abdominal pelvic fins) occurs at Mount Lebanon, and *Sphenocephalus* and *Acrogaster* in the Westphalian Cretaceous deposits. The living surface-dwelling genera *Myripristis* and *Holocentrum* are not uncommon at Monte Bolca, and the latter has also been discovered in the Miocene of Malta.

Wall-case, No. 18. Table-case, No. 55.

The carnivorous marine family of *Scorpænidæ* is represented in the fossil state by a species of *Scorpæna* in the Infusorial Earth of Oran, Algeria, but there are no specimens in the collection.

The *Sparidæ*, or "Sea-breams," have numerous extinct congeners. They are Perciform Acanthopterygians with a curiously specialized dentition, the front teeth being usually adapted for piercing and cutting, and those at the sides of the mouth for crushing. Their earliest representatives, from the Cretaceous of Mount Lebanon, appear to be referable to the living genera, *Pagellus* and *Sargus;* and both these fishes are again found in the Tertiaries, the former at Monte Bolca, and the latter in France and at Oran, Algeria. *Sparnodus* (Fig. 79) is an extinct genus from Monte Bolca, having the teeth somewhat "spaced out"—hence the name. *Sargodon,*

Table-cases, Nos. 55, 56.

Soricidens and *Capitodus* are founded upon detached teeth from various European Tertiaries. And teeth of the living *Chrysophrys* are exhibited from the Miocene of Malta, the Crag of Suffolk, and from probably equivalent deposits in the Canary Islands.

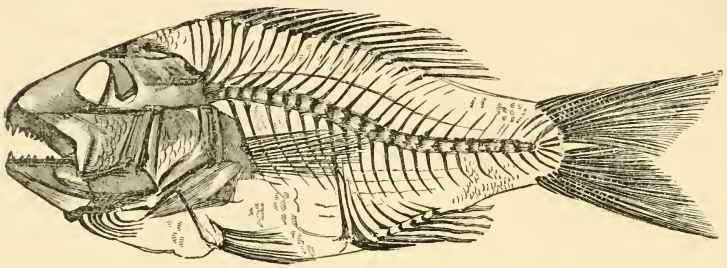

Fig. 79.—*Sparnodus ovalis*, Upper Eocene, Monte Bolca.

Table-case, No. 56.

The *Squamipinnes* are short, deep-bodied fishes, characterized, as their name denotes, by the extension of the scales over more or less of the dorsal and anal fins. The living forms ("Coral-fishes") are mostly brightly coloured fishes which abound in the neighbourhood of coral-reefs. *Platycormus*, from the Upper Cretaceous of Westphalia, seems to be their earliest known representative; and there are remains of *Scatophagus*, and the living genera *Ephippium*, *Pomacanthus*, *Holacanthus*, in the Eocene of Monte Bolca. *Pygæus*, from the same formation, is also placed in this family.

Wall-case, No. 18. Table-case, No. 56.

The *Percidæ*, or Perch family, may perhaps be regarded as the highest—the most specialized—of Teleostean fishes; they are well represented both in the freshwater and marine Tertiary formations. The extinct genus *Smerdis*, with large deeply-forked tail (Fig. 80),

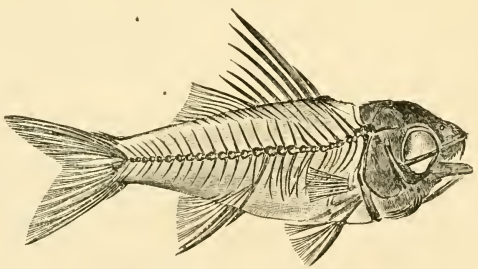

Fig. 80.—*Smerdis minutus*, Eocene, Aix in Provence, France.

occurs in the Miocene of Ulm, Würtemberg, and Puy-de-Dôme, France; in the Upper Eocene of Monte Bolca and Aix in Provence. *Lates*, *Cyclopoma*, and species of the living marine genera, *Dules*, *Serranus*, *Apogon*, *Therapon*, and *Pristipoma*, are also found

at Monte Bolca. *Acanus* is an extinct genus, originally referred to the Berycidæ, from the Eocene Slates of Canton Glaris, Switzerland. The "Bass" (*Labrax*) occurs in the Monte Bolca deposits. Of the Perch (*Perca*) there are extinct species in the Upper Eocene of Aix in Provence, and the Miocene lignites of Central France, in addition to a very large form (*Perca lepidota*) from the Miocene beds of Oeningen, Switzerland. *Paraperca*, from Aix, is also a closely allied form.

Suborder V.—Lophobranchii.

These are a small suborder of Teleostean fishes having the gills not laminated, but in the form of small rounded lobes or tufts. The gill-cover is reduced to a large simple plate; and the body is more or less encased in hard scales, arranged in segments.

Here are placed the "Pipe-fishes" and "Sea-horses," which have but few fossil representatives. An extinct species of *Siphonostoma* is exhibited from the Miocene of Licata, Sicily; and there is also an ancient type of "Sea-horse"—*Calamostoma*—differing from the living *Hippocampus* in the possession of a caudal fin, from the Eocene of Monte Bolca. Another "Pipe-fish," *Solenorhynchus*, has been found in the Eocene of Monte Postale. Table-case, No. 56.

Suborder VI.—Plectognathi.

Like the preceding suborder, the Plectognathi are remarkable for their dermal skeleton, and both these groups were originally placed by Agassiz among the Ganoids, on account of the characters of their armour. Some of these fishes (*e.g. Ostracion*) have the integument converted into a continuous mosaic of hexagonal scutes; in others (*e.g. Diodon*) the skin is covered with numerous isolated spiny ossifications; while others are almost destitute of hard dermal structures. The pelvic fins are either absent or merely represented by spines; and the bones of the upper jaw are nearly always firmly united.

Fig. 81.—Teeth of *Diodon Scillæ*, Miocene, Malta.

The suborder is divided into the two families of *Scleroderm*i and *Gymnodontes*, the former of which have the jaws armed with distinct teeth, while the latter are provided with a kind of edentulous beak. Fossil Scleroderms, in an excellent state of preservation, are found in the Eocene Slates of Glaris, where two extinct genera, Table-case, No. 56.

Table-case, No. 56.

Acanthoderma and *Acanthopleurus*, occur. A species of *Ostracion* has been described from the Eocene of Monte Bolca; and *Glyptocephalus* appears to be another representative of the family in the London Clay of Sheppey. The Gymnodonts also date back to Eocene times. Fine specimens of *Diodon* ("Sea-hedgehogs") are exhibited from Monte Bolca and the Infusorial Earth of Oran, Algeria; and the little piles of dental plates (Fig. 81), placed within the mouth of the same genus, are found in the Miocene of Malta, Sicily, and other localities. *Enneodon* is a closely allied extinct genus, from the Middle Eocene of Monte Postale, N. Italy.

INDEX.

STEPHEN AUSTIN AND SONS, PRINTERS, HERTFORD.

LIST OF SOME OF THE MORE IMPORTANT WORKS IN WHICH MANY OF THE FOSSIL FISHES IN THE BRITISH MUSEUM HAVE BEEN FIGURED AND DESCRIBED.

L. Agassiz, "Recherches sur les Poissons Fossiles," 1833–1843.

L. Agassiz, "Monographie des Poissons Fossiles du Vieux Grès Rouge," 1844.

G. A. Mantell, "The Fossils of the South Downs, or Illustrations of the Geology of Sussex," 1822.

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February,	,, ,, ,, ,, 4.30 ,,
March,	,, ,, ,, ,, 5.30 ,,
April to August,	,, ,, ,, ,, 6 ,,
September,	,, ,, ,, ,, 5.30 ,,
October,	,, ,, ,, ,, 5 ,,
November and December,	,, ,, ,, ,, 4 ,,

Also, from May 1st to July 16th, on Mondays and Saturdays only, till 8 P.M.

And from July 18th to August 29th, on Mondays and Saturdays only, till 7 P.M.

The Museum is closed on Good Friday and Christmas Day.

By Order of the Trustees,

W. H. FLOWER,

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